CONGENITAL ANOMALIES OF FOETUS-ULTRASONOGRAPHIC STUDY"

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CERTIFICATE

This is to certify that this thesis entitled **"CONGENITAL ANOMALIES OF FOETUS – ULTRASONOGRAPHIC STUDY"** is a bonafide work of **Dr. Neeta Pant,** conducted in the Department of Radio-diagnosis and Department of Obstetrics & Gynaecology, M.L.B. Medical College, Jhansi, under my guidance and supervision.

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INTRODUCTION

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Obstetric ultrasound, as no other technique, has permitted the antenatal diagnosis of structural fetal anomalies, such diagnosis is invaluable to counselling women regarding management options once the anomaly is detected. Congenital anomalies or birth defects are defined as abnormalities that develop during intrauterine life and are present at birth. Depending upon the severity, congenital anomalies may be classified into major and minor defects. Major anomalies are defined as defects that require medical or surgical interventions, are life threatening, lead to significant disability, or are of significant cosmetic concern (Marden, PM et al 1964). Minor abnormalities then are the defects that do not require medical or surgical intervention and are of lesser cosmetic concern (Marden, PM et al 1964, Cohen MM Jr; 1982). Examples of major defects include anencephaly, holoprosencephaly, cleft lip and palate, congenital heart defect, etc. Major anomalies are often part of syndromes or associations. Minor defects occur more frequently than major ones; they are often valuable diagnostic clues to the presence of major malformations, and they frequently aid in the recognition of

syndromes. Examples include a third fontanel epicanthal fold, an ear tag, protuberant ears etc.

Major anomalies occur in approximately 5% of live born infants. The most common are congenital heart defects. Nearly 1% of neonates have some type of heart defects. Minor anomalies are present in approximately 15% of all infants and often represent features of syndromes. The occurrence of three or more minor defects in an individual is distinctly abnormal, and when this occurs the individual has a 90% chance of having one or more major abnormalities. Further more 42% of people with idiopathic mental retardation have three or more anomalies of which 80% are minor. These observations suggests that in nearly one half of the cases with idiopathic retardation, abnormal uterine has occurred, which has led directly or indirectly to the retardation. Deformations occur in approximately 2% of the newborns. The rate of occurrence of disruptions and dysplasias is not known.

Contribution of Ultrasound

Ultrasound is playing an ever important role in the in-utero diagnosis and the management of congenital anomalies. Early detection of defects by ultrasound allows decisions to be made

regarding continuation of the pregnancy, in-utero treatment, mode of delivery, post-partum management of the problem, and prenatal counseling of the parents regarding the prognosis and risk of recurrence. No deleterious effects of ultrasound (in the frequencies commonly used in clinical practice) have been documented in either the mother or the fetus. An additional important application is detection of a deformation secondary to uterine constraints. If the fetus is in unusual position, a careful ultrasonic examination should be done, not only to explain why the abnormal positioning has occurred but also to determine if deformations related to the abnormal positioning are present. In these situations, uterine abnormalities and tumors also should be sought. In addition, fetal movements should be looked for, because abnormal movements may predict potential problems in the child at birth.

The presence of hydramnios or oligohydramnios should be determined. Hydramnios is associated with fetal defects as often as 18% to 20% of the time, where as oligohydramnios may result in significant fetal constraints. No detectable amniotic fluid by ultrasound invariably leads to the development of potter sequence and post natal death.

With an understanding of the mechanisms producing congenital anomalies, one is better able to predict complications, treatment needs, and prognosis during and after pregnancy. Another important aspect of ultrasound lies in its ability to make reliable diagnosis of fetal conditions. For instance, in experienced hands the diagnosis of anencephaly can be readily and accurately made and appropriate management could be provided to the patient in time. Ultrasound can, to a limited degree be used to differentiate between malformations, deformations, disruptions, and dysplasias.

Most major structural anomalies of the fetus can be detected by transabdominal ultrasound during the second trimester. The emerging area of first and early second trimester vaginal ultrasound diagnosis of fetal anomalies is now possible. Further clinical work will better define the scope of its potential for successful and consistent early fetal diagnosis.

Most patients in the developed countries like USA have an indication for and undergo sonography during pregnancy. The issue of routine sonography for low risk women continues to be contentious even though the randomized trials have not been able to demonstrate a clear benefit. Although many private obstetricians perform in office

sonography, the highest rate of detection of congenital anomalies are seen in tertiary care settings. In difficult of otherwise high risk cases, a consulting perinatologist is commonly the physician most likely to integrate the ultrasound findings with rational management plan for the remainder of the pregnancy and for the delivery.

As diagnostic quality of ultrasound examination has been improving along with our experience with the diagnosis of congenital anomalies, there is all the more applications of this technique to prenatal diagnosis. An understanding of the classification and pathophysiology of these defects will become imperative than it is now.

In the present study I propose to detect the major congenital structural anomalies in all the pregnant in and out patients as enough, Indian studies are lacking in the present literature despite adequate turnover of obstetric patients. Secondly appropriate management protocol could be planned based on the presence of major or minor congenital structural anomalies thus the perinatal mortality and morbidity could possibly be reduced. Thirdly, incidence of various congenital anomalies could also be evaluated in Indian set up which

could enlighten the domain which needs better and advanced management thus may be rewarding with encouraging results.

AIMS AND OBJECTIVES

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1. This study will be useful in diagnosis of congenital anomalies which are responsible for non-viability of foetus or non-correctable defect so the foetus cannot develop as a normal infant. So early termination of pregnancy is required for example Anencephaly.

2. Those correctable defects diagnosed earlier will help in timely planning and assessment for planned caesarean section.

3. Those defects which are diagnosed in late pregnancy, for ex. Large meningocoele, encephalocoele where the normal labour is not possible, delivery can be planned accordingly.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The subject of fetal malformations is among the most emotionally charged issue that either the parents or diagnostician may have to face. During the past 10 years, ultrasound evaluation has undergone a transformation that has allowed us to answer not only the basic question as to whether the patient is pregnant but also whether a fetal anomaly is present. As smaller and smaller abnormalities are identified, the question now becomes what degree of assurance should a patient expect from a report that no anomaly was seen during a routine ultrasound examination. This is a complex issue. The large number of anatomic structures that can be detected by ultrasound studies have necessitated that anomaly detection, by and large, be a targeted examination. To examine every patient for all anomalies would be highly impractical. Fortunately most major anomalies will be detected as part of a routine evaluation with several minor modifications (Peter W, et al 1994).

Classification of Anomalies

Definitions: Congenital anomalies or birth defects are defined as abnormalities that develop during intrauterine life and are present at birth. As regarding the structural anomalies, congenital anomalies are

classified into major and minor defects depending upon their severity. Major anomalies are defined as the defects that require medical or surgical interventions, are life threatening, lead to significant disability, or are of significant cosmetic concern (Marden PM, et al 1964). Minor anomalies those are the defects that do not require medical or surgical intervention and that are of lesser cosmetic importance (Marden PM, et al 1964; Cohen MM Jr 1982).

Major defects include – Anencephaly

- Holoprosencephaly
- Cleft palate
- Cleft Lip
- Congenital heart defects
- Esophageal atresia
- Imperforate anus
- Renal agenesis.

Major anomalies are often part of syndromes or associations.

Minor defects occur more frequently than major ones; they are often valuable diagnostic clues to the presence of major malformations, and they frequently aid in the recognition of syndromes.

Minor defects include- third fontanel

- Epicanthal fold
- an ear tag
- protuberant ears
- bifid uvula
- neck webbing
- sacral dimple
- mild hypospadias

Incidence

Major anomalies occur in approximately 5% of live born neonate. The most common are congenital heart defects (Peter W et al 1994). Nearly 1% of neonates have some type of heart defects (Nova JJ et al 1978). Major anomalies are also found at higher rate in those babies who die in the perinatal period, and their defects frequently contribute to their death (Mueller RF et al 1983).

Minor anomalies are present in approximately 15% of all infants and often represent features of syndromes (Marden, PM et al 1964). The occurrence of three or more minor defects in an individual is distinctly abnormal, and when this occurs the individual has a 90% chance of having one or more major anomalies (Marden, PM et al

1964). Furthermore, 42% of people with idiopathic mental retardation have three or more anomalies of which 80% are minor. These observation suggest that in nearly one half of the cases with idiopathic retardation abnormal uterine development has occurred which has led directly or indirectly to the retardation. Deformations occur in approximately 2% of the newborns (Cohen MM Jr, 1982). The rate of occurrence of disruptions and dysplasias is not known.

IMPORTANCE OF CONGENITAL ANOMALIES

One measure of the importance of congenital anomalies to society is the contribution of these defects to infant mortality. For instance, in a study reported in 1985, 26% of infants deaths were from birth defects or congenital disorders (Arneil GC et al 1985). Another yardstick is the frequency of inherited and chromosomal abnormalities in the population. Lubs gives the following incidences estimates: Chromosomal anamolies are present in 56 of 1000 live born infants, **autosomal dominant** disorders in 6 of 1000, **autosomal recessive** in 3 of 1000, and **X-linked recessive** disorder in 1 of 1000 (Lubs HA, 1977). Another gauge is the rate of admission to paediatric hospitals that is directly or indirectly related to genetic disorders. For instance, Hall and associates found that 53.4% of

admissions to the Children's Orthopaedic Hospital and Medical Centre in Seatle, Washington, were of genetic conditions (Hall JG et al 1978). The conditions in the admitted patients included 4.5% single gene or chromosomal disorders, 22.1% multifactorial or polygenic problems, 13.6% developmental anomalies, 13.2% familial disorders and 46.6% nongenetic conditions.

The aforementioned data underscore the magnitude of the problem of congenital anomalies. The data do not convey the impact of these defects on the patients. Often unmentioned factors are the emotional upheaval, the financial burden, and the loss of physical and intellectual abilities associated with birth defects. The impact on the individual depends mainly on the severity, the long term problems associated with these defects.

The importance of congenital anomalies and their varied impacts make their earliest detection more and more valuable and of utmost importance thus justifying all the investigative methods for their detection, and **ultrasound examination** is one of such methods. Contribution of ultrasound in the detection of congenital anomalies has been immense as mentioned below later in the Literature. As the diagnostic quality of ultrasound examination

improves and our experience with the diagnosis of congenital anomalies increases, there will be more and more applications of this technique to prenatal diagnosis.

DEFINITION AND CLASSIFICATION PHYSICAL DEFECTS

Spranger and associates (Spranger J et al 1982) described the classification system, which included the entities of **MALFORMATION**, **DEFORMATION**, **DYSPLASIA**, **SEQUENCE**, **ASSOCIATION** and **SYNDROME**, and various combinations of these conditions. Each term denotes the pathogenesis that leads to the particular disorder.

MALFORMATIONS: A malformation is a morphologic or structural defect of an organ, part of an organ, or a larger area of the body as a consequence of abnormal morphogenesis from the beginning of development (Spranger J et al 1982). Examples of some of the more common malformations and the presumed aberrant embryologic processes that give rise to the defects are (Refer Table I).

DEFORMATION: is defined as an abnormal form, shape or position of a part of the body resulting from an abnormal physical or

mechanical force(s) acting on and altering the shape of a previously normal embryonic or fetal structure (Spranger J et al 1982).

DISRUPTION: A disruption is a structural defect of the body resulting from an abnormal breakdown of previously healthy tissue, an organ, part of an organ, or a region of the body. Disruptions are frequently the results of tissue death secondary to tissue injury. Disruption may occur from hypoxia, ischemia, infections, toxins, drugs, or hyperthermia. Disruptions may also arise from mechanical interference with normal embryologic processes. For example, the cleft palate in Robin sequence (Pierre Robin syndrome) represents a disruption.

Table I: Abnormal embryologic processes and resulting malformations.

Type of Abnormal embryologic processes	Examples of malformation produced
Lack of development	Renal agenesis
Hypoplasia	Microtia, Micrognathia
Incomplete closure	Cleft lip, iris coloboma
Incomplete separation	Syndactly
Incomplete septation	Ventricular septal defect
Incomplete migration	Annular pancreas
Incomplete rotation	Malrotation of the gut
Persistence of earlier embryonic structures	Meckels diverticulum, imperforate anus
Persistence of early location	Low set ears, pelvic kidney
Redundant development	Ear tag, polydactly
Aberrant morphogenesis	Polysplenia

DYSPLASIA: Dysplasia is defined as the abnormal organisation of cells or extracellular substances within tissues, which may result in an alteration in tissue morphology. Dysplasia usually involves only one tissue type and differ from the previous terms discussed here in that multiple regions of the body frequently are affected. Examples of dysplasias include bone dysplasia, such as osteogenesis imperfecta, achondroplasia, and thanatophoric dwarfism. Connective tissue

disorders such as Ehlers Danlos syndrome and Marfans and hemangiomas and hamartomas (Spranger J et al 1982).

SEQUENCE, ASSOCIATION, AND SYNDROME

Sequence occurs when a single defect leads to the development of one or more abnormalities. Sequences can be classified into types according to the defects that result. For example Potter sequence which represents the interaction of a single malformation and multiple deformations. The malformation in most cases of Potter sequence is renal agenesis, and the subsequent problems that develop are either direct or on indirect result of this malformation. The resulting condition is then designated as a malformation – deformation sequence.

A **SYNDROME** involving physical defects is present when two or more embryonically unrelated anomalies occur together at a relatively high frequency, and the defects have the same etiology. A syndrome differs from a sequence in that two or more different organs or different body areas must be involved. An example is the Meckel-Gruber syndrome whose major features include encephalocele, polycystic kidneys, and polydactly.

An **ASSOCIATION** is defined as the non-random occurrence of two or more structural defects that occur together less frequently than major defects in a syndrome but more frequently than by chance alone. An example is the VATER association.

OBSTETRIC SONOGRAPHY

Ultrasonography represents the most significant advance in obstetric diagnosis and clinical management in the past 30 years. No deleterious effects of ultrasound (in the frequencies commonly used in clinical practice) have been documented in either the mother or fetus (American Institute of US in Medicine 1988). The largest risk of antenatal sonography is probably misdiagnosis. Although a false diagnosis of a significant abnormality may lead to parental anxiety, these errors can be corrected by a second, usually more detailed, ultrasound study performed in a tertiary referral center. A missed diagnosis remains undetected until the patient undergoes a second sonographic study for another indication. Technology has limitations, and those of obstetric sonography should be discussed with the patient before any study is performed. These limitations are often gestational age – dependent. Thus, obstetric ultrasound should be

performed at an appropriate gestational age by an experienced practitioner.

Antenatal ultrasonography is readily accepted by patients and their families. Patients derive reassurance from the image of a fetus moving about in utero ultrasound studies are commonly requested by the patient during antenatal care, and the study is often attended by the patients friends and extended family.

Current indications for ultrasound in pregnancy are well known and have been established for some time (National Institute of Health, 1840) these are listed in the following table of the article by Wergner and Calhoun. It is estimated that 10% of patients in the United States undergo ultrasound at some time during pregnancy (American College of O & G, 1993). Both the American College of Obstetricians and Gynaecologists (ACOG) and the American Institute of Ultrasound in Medicine (AIUM) have published guideline that detail the components of the basic ultrasound examination in pregnancy (ACOG 1993, AIUM, 1991). The following table II contains a short list of indications for a more detailed study.

TABLE II: INDICATIONS FOR TARGETED ULTRASONOGRAPHY

- Abnormalities of amniotic fluid volume (Hydramnios or oligohydramnios)
- Abnormal maternal serum biochemical markers (MSAFP or triple screen)
- Advanced maternal age with or without abnormal maternal serum biochemical markers.
- Known presence of chromosomal aberration.
- Isoimmunisation with antibodies known to cause hydrops fetalis.
- Teratogen exposure during organogenesis
- Previous history with congenital anomaly
- Family history of congenital anomaly.
- Maternal illness associated with increased risk of congenital anomaly (i.e. DM, seizure disorder).

DETECTION OF ABNORMALITIES IN DIFFERENT SYSTEMS

There is considerable variation the sensitivity of routine ultrasound programme in the detection of abnormalities in different system (Table III).

TABLE III: DETECTION OF FETAL ABNORMALITIES USING ROUTINE SECOND TRIMESTER ULTRASOUND

	Chitty et al., 1991	Shirley et al., 1991	Luck 1992	Crane et al., 1994	Levi et al., 1991	Total % Diagnosed
Central nervous system						
Anencephaly	6/6	10/10	7/7	3/3	6/6	100
Spina bifida	5/5	3/3	2/2	4/5	2/5	80
Encephalocoele	2/2	1/1	1/1		2/2	100
Hydrocephaly	3/3	1/2			4/15	40
Holoprosencephaly	2/3		1/1		0/1	60
Other CNS abnormalities	2/2		2/2		3/6	70
- Total	20/21	15/16	11/11	9/10	17/35	77.4
Pulmonary						
Diaphragmatic hernia	2/2	2/3	2/5	1/1	1/2	61.5
Cystic adenomatoid malformation	4/4	1/1	1/1			100
Pleural effusion	1/3					33
Other		1/1		1/4		40
- Total	7/9	4/5	3/6	2/5	1/2	63
Cardiac						
Ventricular septal defect	1/1		0/1	0/15	0/20	2.7
Atrial septal defect		1/1		0/4	0/6	9.1
Single ventricle	1/3		4/8		1/1	50
Atriventricular septal defect	0/1		2/2		0/1	50
Other complex heart	5/6	4/8	3/14	5/19	2/44	20.9
- Total	7/11	5/9	9/25	5/38	3/72	18.7
Gastrointestinal						
Tracheo-oesophageal atresia	0/2		0/1	0/3	1/7*	7.7
Omphalocoele	3/3	1/1	2/2	1/1	2/2	100
Gastroschisis	1/1	1/1	2/2		2/2	100
Small bowel obstruction/atresia	0/1	0/1	1/1	1/1	0/1	40
- Total	4/7	2/3	5/6	2/5	5/12	56.3
Urinary tract abnormalities						
Obstructive uropathy	10/10	7/8	99/99	28/29	2/25	85.4
Renal dysplasia	5/8	0/1	4/4		4/11	54.2
(unilateral)	(3/5)		(4/4)			
(bilateral)	(2/3)	(0/1)				
Renal agenesis	5/5		2/2		3/4	90.9
(unilateral)	(1/1)					
(bilateral)	(4/4)		(2/2)		(3/4)	
Prune belly syndrome					3/3	100
Other	½			6/6	0/1	77.8
- Total	21/25	7/9	105/105	34/34	12/44	66.1

	Chitty et al., 1991	Shirley et al., 1991	Luck 1992	Crane et al., 1994	Levi et al., 1991	Total % Diagnosed
Skeletal abnormalities						
Limb reduction defect	2/5	1/1	1/2	2/5	0/1	42.9
Talipes	6/12	0/6	2/2**	2/24	3/14	22.4
Spinal abnormality	3/3		1/1	0/1	0/2	57.1
Dwarfism	2/2	1/1	2/2		0/2	71.4
Other skeletal abnormalities	4/5		0/1		¼	50
- Total	17/27	2/8	6/8	4/30	4/23	34.4
Other						
Cystic hygroma	1/1	2/2	1/1	2/2	5/5	100
Facial cleft	2/9	3/9		3/10	0/11	20.5
Hydrops	2/2	0/1	1/1	0/2	2/6	41.7
Multiple abnormality/syndrome	18/19	3/4	5/6		1/5	61.4
Chromosomal						
Trisomy 21	1/14	3/10				16.7
Trisomy 18	1/1	3/3				100
Trisomy 13	½					50
Other	0/4					0
- Total	3/21	6/13			3/15	24.5

N.B.

1. Only studies which differentiate between women scanned and abnormalities detected and after 24 weeks' gestation are included in this table.
2. The term 'other' may include some of the specific abnormalities listed in some systems as not all authors differentiate between abnormalities.
3. This table lists selected abnormalities only and does not give all the abnormalities reported in the papers.

* ? Includes oesophageal atresia and tracheo-oesophageal atresia.

** Severe cases only reported.

REASONS OF NON DETECTION OF ABNORMALITIES

There are many reasons why an abnormality may not be detected (Table IV). These include technical difficulties, absence of sonographic sign associated with an abnormality the late appearance of the ultrasound abnormality as well as failure (for whatever reason)

to scan the fetus. It is therefore unlikely that routine screening programmes will ever achieve 100% detection of fetal abnormalities.

TABLE IV: REASONS FOR FAILURE TO DETECT AN ABNORMALITY IN ROUTINE ULTRASOUND SCREENING PROGRAMMES.

Reason	Example
Patient non-compliance	Declines scan Late booker
Technical difficulties	Maternal obesity Fetal position Multiple pregnancy
Absence of sonographic sign	Tracheo-oesophageal fistula Down syndrome with no structural abnormality
Late appearance of sonographic sign	Duodenal atresia Small bowel obstruction Hydrocephalus Microcephaly Obstructive uropathies Pleural effusions

Craniospinal abnormalities

All recent studies, where routine screening is performed in the mid second trimester, report 100% detection of anencephaly and many achieve rates approaching 100% for open neural defects. In the early days of obstetric scanning the sensitivity of ultrasound for the detection of neural tube defects was poor (Approx. 50%) (Persson et

al, 1983; Roberts et al, 1983). Compared with measurement of maternal serum Alpha-feto protein (MFAFP) which would identify about 80% of fetuses with open spina bifida (Report of the UK collaborative study, 1975), but 3.5% of normal fetuses are also identified as being at increased risk. The main reason for the improvement is the recognition of the cranial signs associated with spina bifida and the Arnold Chiari malformations. There are the **'LEMON'** signs resulting from scalloping of frontal bones, and the **'BANANA'** sign which refer to the abnormal shape of the cerebellum (Nicolaide et al, 1986, Thiagaragah et al, 1990). Both appearances are thought to be a result of traction on the brain stem. Using these cranial signs in high risk population, nearly all fetuses with open spina bifida can be successfully identified before 20 weeks (Thiagragah et al 1990, Vanden Hof et al 1990; Watson et al 1991). A prospective evaluation in a low risk population has confirmed the value of Lemon and Banana signs (J. Campbell, unpublished data). In this study of 11778 pregnancies, there were 8 cases of spina bifida. All had an abnormal cerebellum (absent or banana shapped) and 7 had a Lemon sign. The 8^{th} was scanned after 26^{th} wks gestation and the skull was normal. The disappearance of Lemon sign as pregnancy

progresses has been reported by others and it seems that this aid to the diagnosis of neural tube defects is only useful prior to 24 weeks (Van der Hof et al 1990; Nyberg et al, 1988).

Other intracranial abnormalities are detectable in the second trimester but unfortunately most studies in the literature do not differentiate between the types of abnormality. It is clear, however, that the sonographic signs associated with some intra-cranial abnormalities, in particular microcephaly and hydrocephaly, may develop later in the pregnancy and would, therefore, only be detected if a scan was initiated because of a clinical indication or if a third trimester scan were routinely offered. This is well illustrated in the study from Belgium (Levi et al., 1991) where only 4 of 20 cases of hydrocephalus were identified by scanning before 22 weeks' gestation, with the remainder being identified later in pregnancy. Similarly only half of the cases of microcephaly (2 of 4) were identified in the 2nd trimester.

CARDIOVASCULAR ABNORMALITIES

Cardiac abnormalities are amongst the more common congenital abnormalities found in live births, occuring in about 1 in every 120 births (Forfar & O'Neill, 1978) and about half of these are

likely to be life threatening. It has been suggested that about 50% (i.e. 2 per thousand) of the severe heart defects could be detected by routinely examining the 4-chamber view of the foetal heart (Allan et al, 1986). Several studies report that at gestation of 18 weeks or greater this view can be obtained in upto 98% of foetuses and that examination of 4 chamber view of heart during the routine scan improves the detection of congenital heart abnormalities (Sharland & Allan 1992; Tegender et al, 1995; Vergani et al, 1992). However, the sensitivity of routine ultrasound in the detection of cardiac abnormalities in most studies reported is low. Sensitivities vary from 2 to 67% but, in view of significant differences in prevalence of neonatal cardiac abnormalities reported in these studies, is likely that the higher figures are a result of poor postnatal ascertainment. Routine ultrasound examination can certainly improve the detection of cardiac abnormalities since in the RADIUS study 435 of complex cardiac lesions were detected in the ultrasound screening group compared with 21% of controls (Ewigman et al., 1993). Furthermore, the referral pattern to tertiary centres for echocardiography has changed significantly, with an increasing proportion being referred because of a supspicion on routine ultrasound rather than on the basis of

relevant family history (Allan, 1989). Other evidence for some success of routine scanning comes from the observation that these has been a significant fall in the number of neonates with hypoplastic heart syndrome seen at a supra regional referral centre (Allan et al., 1991).

Sensitivities reported in those studies looking only at the detection of cardiac abnormalities using the 4-chamber view range from 7 to 81% (Achiron et al., 1992; Tegander et al., 1995; Vergani et al., 1992). The higher sensitivities are likely to be a result of later gestational age at scanning, a policy which includes re-scanning if the 4 chamber view of the heart is not adequately identified on the first occasion, increased scanning time and/or relatively poor ascertainment of abnormalities in the neonate.

In the recent report from Norway (Tegander et al., 1995) (sensitivity 7%) ascertainment of postnatal abnormalities was likely to be greater as follow up of neonates extended well beyond the neonatal period (Prevalence 12/1000) whereas in the other two studies (sensitivity 48 and 81%) the prevalence was lower (4 and 5.2 per thousand), probably because of relatively short follow up period (one week). The Norwegian study (Tegander et al., 1995) probably

gives the most realistic estimate of efficacy of routine ultrasound in the detection of cardiac abnormalities. When critical lesion (i.e. those which were likely to require surgery) were considered, 26% were detected by routine scan. In 4% of the cases the 4-chamber view was not visualized and, due to practical difficulties, no arrangement was made for rescanning. Three critical lesions occurred in this group (many more that might have been expected). In the group classified as non critical, none had required surgery and many had resolved spontaneously. There are many serious cardiac abnormalities which will have a normal 4-chamber view of the heart at 18-20 weeks' gestation. If examination of the fetal heart is extended to include views of the great vessels the number of cardiac defects detected are reported to increase from 48 to 78% (Achiron et al., 1992). Extending the examination requires time, both to train the sonographers and to perform the examination, and further evaluation of routine detailed fetal cardiac scanning should be undertaken.

Congenital heart abnormalities are good illustrations of how difficult it can be to define what is considered abnormal or clinically significant. Many small ventricular or atrial septal defects do not require treatmnt and will close spontaneously (Tegander et al., 1995).

It may well be that the delay in closure in some cases is part of the spectrum of normality and therefore it is difficult to know whether or not to define them as congenital heart defects or not (Hiraishi et al., 1992). It may be better to give detection rates in terms of clinically significant abnormalities although this may well be very difficult to define.

GASTROINTESTINAL ABNORMALITIES

Anterior abdominal wall defects are regularly detected by routine ultrasound and most studies report a 100% detection rate for omphalocoele and gastroschisis. However, the diagnosis of intestinal obstruction or atresia is less amenable to diagnosis in the second trimester, because the classical signs of the dilated stomach or proximal loops of small bowel do not appear until later in pregnancy. These abnormalities are often detected because of polyhydramnios which initiates a scan in later pregnancy. Isolated oesophageal atresia may be diagnosed if there is failure to visualise the stomach bubble on several occasions. In 955 of these cases there is a co-existent fistula to the trachea so that the stomach can fill via the trachea and thus the bubble will be visualized, although polyhydramnios may occur later in pregnancy. In the three studies

which listed the types of intestinal atresia separately (Crane et al., 1994; Chitty et al., 1991; Luck, 1992) none of the six fetuses with tracheo-oesophageal atresia were identified in the second trimester. All anterior wall defects were identified and two of the four small bowel obstructions were diagnosed.

PULMONARY ABNORMALITIES

Probably the most common abnormality of the respiratory system is a congenital diaphragmatic hernia which occurs in about 1 in 2000 to 1 in 5000 births as illustrated -Table 5, this abnormality can be diagnosed at a routine second trimester scan, but in fact many were diagnosed later in pregnancy when a scan was initiated because of the associated polyhydramnios. Other pulmonary abnormalities include cystic lung lesions such as cystic adenomatoid malformation (CCAML) and pleural effusions. The majority of cases with CCAML were diagnosed at the time of the routine scan but in many instances there was no confirmation of prenatal diagnosis as the natural history of this condition in many cases is for apparent resolution of the lesion in utero. This apparent resolution often results in the neonatal chest radiograph appearing normal. It is worth noting, however, that more detailed examination in some cases

(computerized tomography or magnetic resonance imaging) has revealed the presence of a significant abnormality in the lung despite a normal radiograph (Kakoo et al., 1993). This is an example of an area where the natural history and clinical significance of a sonographic sign needs further evaluation.

Table V: Sonographic features often associated with common chromosomal aberrations

	Trisomy21	Trisomy 18	Trisomy 13	45,XO
Ventriculomegaly	+	+	-	-
Holoprosencephaly	-	-	+	-
Choroid Plexus Cysts	occ	+	-	-
Neural Tube Defect	-	+	occ	-
Micrognathia	-	+	+/-	-
Cystic Hygroma	+	-	-	+
Facial Cleft	-	Unilateral	Midline	-
Cardiac Abnormalities	+	+	+	+
Diaphragmatic Hernia	-	+	-	-
Omphalocoele	-	+	+/-	-
Renal Abnormalities	Mild Pyelectasis	+	+	+
Duodenal Atresia	+	-	-	-
Fisted Hand	-	+	-	-
Polydactyly	-	-	+	-
Radial Aplasia	-	+	+/-	-
Talipes	-	+	+/-	-
Rocker-bottom feet	-	+	+/-	-

Occ = occasionally

Urinary tract abnormalities

Abnormalities of the renal tract are commonly diagnosed prenatally. Reports of routine screening programmes would suggest that virtually all cases of hydronephrosis, the vast majority of bilateral renal agenesis or dysplasia as well as many unilateral lesions were diagnosed at the time of the routine scan. However, in 5 of the

studies (Crane et al., 1994; Chitty et al., 1991; Levi et al., 1991; Shirley et al., 1992; Levi et al., 1995) cases of mild hydronephrosis or mild pyelectasis were not reported. In the series reported from Ascot it would appear these were included, but details of the postnatal follow-up were not given and it is unlikely that all were pathological after birth. A prospective screening programme in Staffordshire reported that a total of 92 fetuses examined at around 28 weeks' gestation were thought to have a renal abnormality, but postnatal examination could only confirm the abnormality in 46% of these cases (Livera et al., 1989). Furthermore complete ascertainment of urinary tract abnormalities is impossible unless all neonates are scanned at birth and then subsequently followed up into infancy. This was not the case with any of the studies reported. In addition, the incidence of hydronephrosis at birth in the ultrasound screened group (29/7685) in the RADIUS study was four times greater than the control group (7/7596) (Ewigman et al., 1993). This difference reflects the impact of ultrasound screening, and indicates the clinically silent nature of most renal problems. Other studies in the literature describe improved detection rates of urinary tract abnormalities by scanning later in pregnancy (Helin and Persson, 1986; Ecornomou et al.,

1994). However, the true clinical significance of many of the prenatal findings, even when confirmed in the neonatal period, are unclear as the majority of neonates are clinically asymptomatic. The long term significance of these prenatal findings awaits further study.

SKELETAL ABNORMALITIES

Visualization of the fetal long bones at the time of a routine scan is usually achieved and measurement of the femur is often incorporated as a routine part of the examination. Many of the lethal skeletal dysplasias have severe limb shortening which is evident by 18 weeks making many amenable to detection with routine ultrasound as demonstrated by the relatively good detection rates of skeletal dysplasias in the routine ultrasound screening programmes reported (Table 4). However, examination of the hands and feet may be more difficult and often there are time constraints which prevent detailed examination of the extremities. This results in relatively poor detection rates for abnormalities such as talipes and limb reduction defects.

ULTRASOUND SCREENING FOR CHROMOSOMAL ABNORMALITIES

Many of the more commonly occurring karyotypic aberrations are associated with structural abnormalities which are amenable to prevent detection with ultrasound (Table 5). Studies in tertiary referral centres have found that all fetuses with Trisomy 13, 77% of fetuses with Trisomy 11 and between 33 and 44% of fetuses with Down Syndrome have significant structural abnormalities which may be detected by a second trimester scar (Benacerraf et al., 1988; Nyberg et al., 1990; Benacerraf et al., 1987). However there is a prospective study in low risk patients which addresses this aspect of second trimester ultrasound screening. The risk of a chromosomal abnormality increases with increasing numbers of abnormality in the fetus (Nicoalaides et al., 1992) and when multiple abnormalities are present the overall risk may be as high as 35% (Rizzo et al., 1990). In the three studies of routine ultrasound where detection of chromosomal abnormalities was reported, overall 25% (12 out of 49) fetuses with an abnormal karyotype were detected following the identification of a sonographic abnormality (Chitty et al., 1991; Shirley et al., 1992; Levi et al. 1991).

There are many minor structural abnormalities which are reported to be associated with abnormal karyotypes (Table 6). Some of these have potential for use in screening the low risk population for fetal karyotypic abnormalities in that they can be relatively easily visualized at the time of a routine scan. These include choroid plexus cysts, mild pyelectasis, nuchal oedema and mild ventriculomegaly. Others such as clinodactyly, sandal gap, polydactyly, clenched fists etc. are less readily seen and are signs which should be sought in fetuses known to be at increased prior risk or where another sonographic abnormality has been found. One of the main problems with using these markers in the low risk population is that the majority of studies reported pertain to selected populations and extrapolation of the associated risks to low risk women can be difficult. A good example is the choroid plexus cyst which was first identified in 1984 when it was described as a benign transient finding (Chudleigh et al., 1984). Following this, there were several reports of the association of choroid plexus cysts and Trisomy 18 and a review of the literature in 1986-1987 seemed to indicate that the risk of Trisomy 18 in the presence of isolated choroid plexus cysts was of the order of 10%. However, as other larger series, and in particular series of unselected

pregnancies, have been reported the associated risk for karyotypic abnormality has fallen and in 1995 pooled risk for unselected populations is between 1 and 2% (Chitty, 1994). However, the vast majority of those studies failed to take into consideration other risk factors, for example raised maternal age or abnormal maternal serum biochemistry. If age is taken into consideration, then the risk falls further to about 1 in 300 in a fetus with isolated choroid plexus cysts where the mother is under 37 years of age (Chitty and Chudleigh, in preparation). Further evaluation of the efficacy of other minor markers in the detection of chromosomal abnormalities in the low risk population is needed and care should be taken before applying figures obtained from the high risk population to the low risk pregnancy. The use of sonographic markers in combination with maternal serum biochemistry also needs further investigation.

Table VI: Minor sonographic signs which may be associated with autosomal Trisomies

Abnormality	Trisomy
Nuchal Translucency (Ist Trim)	21,18,13 + others
Choroid Plexus cysts	18 (occasionally 21)
Ventriculomegaly	21 + 18
Enlarged Cisterna Magna	18
Nuchal Oedema (2^{nd} tm)	21
Facial Cleft	18 + 13
Clinodactyly	21
Fisted Hand	18
Polydactyly	13
Mild Pyelactasis	21 + others
Relatively Short Femur	21
Talipes	18 + 13
Rocker-bottom Feet	18 + 13

Trim = trimester

First trimester ultrasound screening for chromosomal abnormalities

In 1989 Bronshtein et al. Reported the association of nuchal translucency, detected in the first trimester, and abnormal fetal karyotypes. Since then there have been many reports, mostly on selected populations at known increased risk, confirming this observation. If all the published data is pooled then any fetus at increased prior risk for chromosomal abnormality with a nuchal translucency measurement of 3mm or greater has on average a 1 in 4 chance of having an abnormal karyotype. However, sensitivity of this sign for the detection of chromosomal abnormalities in the low risk population has yet to be proven. Few studies of unselected populations have been reported (Pandya et al., 1995; Roberts et al., 1995; Bewley et al., 1995; Bower et al., 1995). These studies were based on the routine booking population and all women who attended early enough to be scanned between 10 and 14 weeks' gestation were included. A summary of the results is shown in Table 7 (The report by Bower et al. Includes the data in the papers by Bewley et al and Roberts et al.). The overall risk in the presence of a positive nuchal translucency sign was 5.5%. However, in the study by Bower

et al. (1995) all fetuses with an abnormal nuchal translucency measurement which were subsequently found to have an abnormal karyotype were at increased prior risk because of raised maternal age or past history. In that study one woman aged 29 years of age gave birth to a baby with Down Syndrome. The nuchal translucency had been measured in the first trimester and was less than 3mm. These studies report relatively small numbers and further evaluation of low risk pregnancies is needed before this can be applied as a routine screening test to all pregnancies, although the value of nuchal translucency measurement in the pregnancy at increased risk seems proven.

ADVANTAGES AND DISADVANTAGES OF ROUTINE SCREENING

The skill of the sonographer, gestational age at scanning and postnatal ascertainment of abnormalities all account for the discrepanies in the studies reported, but is clear that if the staff are adequately trained and scanning is performed at 18-20 weeks gestation, a significant proportion (Chitty et al., 1991, Shirley et al., 1992) of lethal to severely disabling abnormalities (as well as many less serious ones) can be detected by a routine scan in low risk

pregnancies. What, though, are the potential advantages and disadvantage of routine screening for fetal abnormalities (Table 8)?

Effects on Perinatal Morbidity and Mortality

There has been very little formal evaluation of the benefits of routine ultrasound screening for fetal malformations. The Helsinki study demonstrated a significant reduction in the perinatal mortality late in their ultrasound screened cohort, much of which was due to the detection and subsequent termination of pregnancy in cases complicated by serious fetal malformations. Giving parents the option to terminate a pregnancy where the fetus has been found to have a lethal or severely disabling abnormality is clearly a potential advantage of a programme which screens for fetal abnormalities, albeit that the parents may be faced with difficult and unexpected decisions. Certainly not all parents will elect to terminate the pregnancy, and the forewarning of the outcome of the pregnancy can prove valuable. In a study of 5 such couples who decided to continue the pregnancy following the diagnosis of a lethal abnormality, all said that they found the time to prepare themselves and their families for the sad outcome of the pregnancy useful (Chitty et al., 1995).

There is also potential for a reduction in perinatal morbidity in neonates requiring early neonatal surgical or paediatric interventions. The prior knowledge of the presence of a fetal abnormality allows both for early implementation of therapy, and for planning of the delivery in a unit with the appropriate facilities.

Table VII: Efficacy of nuchal translucency measurement (nt) at 10-14 weeks in unselected populations.

Study	Fetuses with nt > 3mm			Fetuses with nt < 3mm		
	Normal	Abnormal	% Abnormal	Normal	Abnormal	Mean maternal Age
Pandya et al., 1995	59	4	6.3	1699	1	29.3
Bower et al., 1995	159	8*	4.8	2465	7**	29

* All high risk pregnancies

** 6 of 7 were high risk pregnancies.

Table VIII: Advantages and disadvantages of routine ultrasound for the detection of fetal Abnormalities.

Advantages

Reassurance of normality

Time for parents to prepare

Planning of delivery – timing

- availability of paediatric service

Intra-uterine therapy

Option to terminate the pregnancy

Disadvantages

False positive diagnosis – unnecessary abortion

- increased parental anxiety

Inability to accurately define prognosis

Safety?

False negative diagnosis

Studies have shown that there is a reduction in morbidity in fetuses with gastroschisis, intestinal obstruction and cardiac abnormalities when the diagnosis has been made prenatally and delivery and

postnatal treatment planned accordingly (Romero et al., 1989; Chang et al., 1991). These factors may influence longer term mortality and morbidity, but further study is needed before this benefit is proven (Chang et al., 1991). Other investigators claim that the prenatal detection of renal abnormalities is beneficial and may reduce morbidity from reflux or infection. In one prospective study of 92 fetuses with a prenatally diagnosed urinary tract abnormality, 42 had the abnormality confirmed postnatally and the authors considered that in about half of these cases the baby had benefited from the prenatal diagnosis in that it allowed early treatment either surgical or chemoprophylaxis (Livera et al., 1989). Another study confirmed these observations and suggested that, in their series, benefit was conferred in about 755 of cases which would have otherwise remained clinically silent (Greig et al., 1989). However, the high false positive rate reported in the first study where 50 of the 92 abnormalities were not confirmed postnatally, undoubtedly induced considerable unnecessary parental anxiety.

Parental reassurance

The majority of fetal abnormalities occur in pregnancies at low risk. Increasingly parents are aware that they all face a small but

measurable risk of fetal abnormality in any pregnancy, and so possibly the greatest advantage of routine fetal anomaly scanning is the reassurance it gives to most parents. The specificity reported for most ultrasound screening programmes is high (99.9-100%) and thus the majority of parents are correctly reassured. However, a few parents will be falsely reassured and their baby will have an unexpected abnormality. There have been no studies of the psychological consequences for parents where fetal anomalies have been missed. Either following ultrasound or other screening tests for fetal anomalies, although parental anger in response to false reassurance has been reported. It is important that parents are aware of the possibility of a false negative (or false positive) diagnosis. In view of this the Royal College of Obstetricians and Gynaecologists (Drife and Donnai, 1991) recommended that a written explanation of the reasons for and limitations of a scan should be given to women. Nevertheless pre-scan counselling has been described as extremely poor in most British hospitals, and poorer than that provided for many other screening tests (Smith and Marteau, 1995). Further study is needed to determine the optimum way of preparing women for their scan in order to minimize any adverse psychological effects.

Parental preparation for an abnormality

In cases where the parents are faced with the unexpected finding of a fetal abnormality and the pregnancy continues, the prior knowledge may be helpful in allowing them to come to terms with the birth of a child with a congenital abnormality. This is an area which lacks formal study and there are only anecdotal accounts which support this view. However, it is not uncommon to receive a request to scan a pregnancy at increased risk of an abnormality (for example a facial cleft), not because the parents would seek an abortion if the fetus were affected, but because they would like the fore-warning. Prior knowledge of a fetal abnormality which will require surgery or other paediatric interventions also allows time for the parents to meet and discuss the postnatal management with the relevant health professionals, to see the neonatal intensive care unit if necessary and to adjust to the fact that their baby will have to spend some time in hospital after delivery. However, there is also evidence, again anecdotal, that for some parents the detection of an abnormality may cause so much concern that it impairs the parents ability to cope with the child after birth (Griffiths and Gough, 1985).

False positive diagnoses

Most reports of routine ultrasound screening programmes give very low incidences of false positive results and none resulted in the termination of a normal fetus, although this is obviously a potential risk. However, even the finding of a relatively minor abnormality, which is subsequently not confirmed, can cause considerable anxiety to the parents, the effects of which may last for some time after the birth of their child (Marteau et al., 1989). An example would be anomalies of the urinary tract which are amongst those most frequently diagnosed prenatally, but where the incidence of false positive diagnoses can be high (Livera et al., 1989), particularly if mild pyelectasis is considered (Corteville et al., 1991). Upto 50% of fetuses with prenatal pyelectasis may have a normal neonatal ultrasound scan, and the majority of those with a postnatal abnormality will be asymptomatic with only mild to moderate degrees of upper tract dilatation. The clinical significance of the postnatal findings in the majority of cases is unclear. Further studies of the natural history of upper tract dilatation in the neonate are required before the true significance, in terms of postnatal renal function prenatal pyelectasis becomes clearer. Prenatal studies are also

needed to try and define factors, which may predict outcome more accurately and thus reduce the incidence of false positives. There are many other examples of these minor changes (echogenic bowel, choroid plexus cysts, second trimester nuchal oedema, mild ventriculomegaly etc) which affect up to 2% of fetuses. Many may in fact be a variant of normal and there is an urgent need for large studies of low risk populations to accurately define the risks associated with these markers.

Difficullty in defining prognosis

The unexpected discovery of an abnormality in a fetus is a source of great anxiety, which is often compounded by an inability to give the parents accurate prognostic advice. In some cases the diagnosis may be clear but the pregnancy outcome very variable. In the case of a diaphragmatic hernia for example, the mortality is high but if the child survives surgery then the long term prognosis is usually good. Other diagnosis may give rise to more difficult decisions. The finding of ventriculomegaly or agenesis of the corpus calloum are good examples. The incidence of mild ventriculomegaly in the normal population is unknown but agenesis of the corpus callosum has been reported as an incidental finding in postmortem

examinations of normal people. On the other hand both mild ventriculomegaly and agenesis of the corpus callosum are relatively common findings in children with developmental delay (Jeret et al 1987). When detected prenatally both may be associated with an abnormal fetal karyotype, but once this has been excluded the prognosis is very variable. Review of the cases reported in the literature would suggest that the residual risk of handicap for both mild ventriculomegaly and agenesis of the corpus callosum (Gupta and Lilford 1995) is of the order of 15%, much of which would be for significant degrees of developmental delay. However, these figures are derived from reports of selected cases, mainly reviewed retrospectively with very variable follow-up. Structured follow-up studies, looking both at the long-term paediatric outcome and the prenatal findings in more detail to try and elicit more reliable prognostic markers, are required in order to provide more accurate figures for counselling in these and other similar situations. When screening women, who have a previously affected child, the outcome in these situations is often clear, but there can be considerable difficulty in giving a confident prognosis in the low risk population.

Safety

As with most other aspects of routine ultrasound screening, there has been little formal evaluation of the safety of this procedure. None of the controlled studies have shown any early adverse effects of routine ultrasound. However, in all the studies reported many of the control group also underwent ultrasound, although usually at a later stage than the screened groups. Whilst these studies did not demonstrate any evidence to suggest that significant harm is done to the developing fetus, a recent paper from Australia found that fetuses exposed to repeated ultrasound and doppler examinations tended to have slightly lower birthweights (Newnham et al., 1993). However the difference between the group exposed to the frequent doppler and those in the control group was small and the finding was an incidental one. The authors concluded that further study looking specifically at this aspect was required. Furthermore the exposure to ultrasound in this study was much greater and more frequent than that which would normally occur during routine ultrasound screening for fetal abnormalities.

The Norwegians performed two randomized controlled studies of ultrasound during 1979-1981. The screened group had been

exposed to ultrasound at 16-22 weeks and most of the controls had not, although many were scanned later in pregnancy (Bakketeig et al., 1984; Eik-Nes et al., 1984). These cohorts of babies have recently been followed up to the age of 8-9 years. There was no difference in postnatal growth, reading and writing skills (Salvesen et al., 1992a) or vision and hearing at the ages of 4 and 7 (Salvesen et al., 1992b) in the screened and control groups, although the data suggest a possible association between routine ultrasound exposure and subsequent non-right-handedness (Salvesen et al., 1993).

ALTERNATIVE SCREENING POLICIES

First trimester ultrasound screening

With improved technology, in particular the development of transvaginal ultrasound probes, it has become possible to examine the fetal anatomy in detail in the first trimester (Cullen et al., 1990; Timor-Tritsch et al., 1992). The advent of widespread maternal serum screening for Down syndrome means that there is a clinically driven need to scan before 16 weeks gestation to confirm the gestational age. There is therefore a potential economic advantage in considering routine first trimester anomaly scanning, but there are relatively few reports of such programmes (Bronshtein et al., 1991;

Ecomomides et al., 1995), although there are many papers looking in detail at high risk populations or specific abnormalities. One of the studies describing its value in screening for fetal malformations reported an overall incidence of congenital anomalies of 2.6% in fetuses examined between 9-16 weeks gestation with transvaginal ultrasound (Rottem and Bronshtein, 1990). However, they do not define their population, or give details of any false negative results, although they do comment that anomalies involving the obstruction of the passage of fluids may not be detected until later in pregnancy. Another study compared transabdominal with transvaginal ultrasound (Achiron and Tadmor, 1991). They found an improved detection rate using transvaginal ultrasonography, but also reported a significant proportion of abnormalities which were not seen when scanned before 13 weeks but which were clearly visualized at a routine 18-20 week scan. As with second trimester screening there may be interpretational difficulties, for example the spontaneous resolution of cystic hygroma detected in the first trimester has been reported (Cullen et al., 1990) and in the study from Israel 81 of the anomalies detected by transvaginal scanning between 9-16 weeks were transient, although there was a high rate of aneuploidy in the (6.1%)

(Bronshtein et al., 1991). Economides et al. (1995) reported high incidences of choroid plexus cysts (3.6%) and hydronephrosis (3.2%) in fetuses scanned at 12-13 weeks and the natural history of abnormalities (some of which may be physiological variants) needs to be more accurately defined before this technique can be considered for widespread application to the low-risk population. Whether or not it could be considered as an alternative to the second trimester scan is also doubtful, in view of the relatively high false negative rates reported.

An alternative policy would be to screen at booking in the first trimester and then only scan at 18-20 weeks if there is a clinical indication, positive family history, abnormal maternal serum screening etc. However, this may still result in an unexpectedly high false negative rate. In the study described above (Achiron and Tadmor, 1991), the five abnormalities missed in the first trimester were hydrocephalus, agenesis of the corpus callosum, bilateral hydronephrosis and two major cardiac defects. None of these would have altered the serum biochemistry or would be likely to stimulate another clinical cause for a scan in the second trimester. Chambers et al. (1995) report the audit of a screening service for fetal

abnormalities using early ultrasound (mainly for dating purposes) and maternal serum alphafetoprotein estimation combined with selective scanning. The sensitivity of this programme was 37% before 24 weeks. The authors classified those abnormalities not detected as 'usually detectable' or not. Of those which they considered were detectable, 9 of 19 resulted in fetal or neonatal death. They therefore concluded that the implementation of a routine screening policy would benefit relatively few women. Routine and indication based (without first trimester scanning) screening for fetal malformations has been compared (Bernaschek et al., 1994). More malformations were detected prior to 24 weeks by means of the screening-based (18%) than the indication based (5%) screening. This was not a randomized study, but a retrospective one comparing the different policies in operation at different times indication based in 1983-1984 and routine screening in 1990-1991. There are therefore several confinetesy factors which may have influenced these results, not least the fact that the technology and understanding improved considerably between the two study periods. In a similar study, again retrospective, but studying groups scanned over the same time period in a unit which used maternal serum alphafetoprotein measurement, 45% of

abnormalities were detected in the fetuses scanned routinely at 16 weeks or later compared with only 30% in those scanned at booking only. The authors further refined the latter figure to 17% if only those booking scans done prior to 16 weeks were included (Constantine and McCormack, 1991). However, none of these studies claim to have examined the fetal anatomy in detail at the time of the early scan.

MATERIALS AND METHODS

MATERIAL AND METHODS

Present study was conducted in the Department of Radio-diagnosis MLB Medical College Jhansi. Patients were those who attended out patient and admitted in Department of Obstetrics and Gynaecology MLB Medical College Jhansi, during the period from June 98 to July 99. The patients those included in study were, beyond 12 weeks of gestation.

All the patients were subjected to detailed ultrasonographic examination using ULTRAMARK IV Plus Machine using 3MHz Probe.

SCANNING TECHNIQUE: Each patient was examined for detailed history previous obstetric history, history of drug intake, Diabetes, smoking, Alcohol, history of congenital anomalies. History of consanguinous marriage was also taken.

The patients were examined in the supine position.

The lower abdominal wall was liberally smeared with coupling agent to secure absence of air gap between the transducer and skin surface. Gain was adjusted to produce best image by positioning the transducer vertically.

1. **DOCUMENTATION OF FOETAL NUMBER, LIE AND PRESENTATION**

Multiple pregnancies require the reporting of additional placental number, sac number, comparison of foetal size and when visualized foetal genitalia and presence or absence of interposed membrane.

2. **ESTIMATION OF AMOUNT OF AMNIOTIC FLUID:**

a) Single deepest pocket measurement: Assessment of amniotic fluid volume using single deepest method involves measuring the maximum vertical depth of any amniotic fluid a measurement below 1 to 2 cm considered to represent oligohydramnios and one above 8 cm represents polyhydramnios.

b) Four Quadrants amniotic fluid index: The amniotic fluid index is determined by dividing the uterus in to four quadrants by sagittal and transverse lines through the umbilicus and summing the vertical dimensions of the deepest quadrants. When the sum result a value below 50 cm, it is considered to signify oligohydramnios and the one above 18-20 mm, polyhydramnios.

3. **PLACENTAL LOCATION**: Placenta examined in relation to uterine wall and distance from **internal cervical os** patients those examined before 28 weeks and showed low line placenta were looked for its **migration/hemorrhage/dissection**. Maturity of placenta is being classified from grade 0 to grade III.

4. **ASSESSMENT OF GESTATION AGE:** It was accomplished using a combination of Biparietal diameter, Head circumference, Femur length and abdominal circumference.

   Biparital Diameter: should include cavum septum Pallucidi and thalamus

   Head circumference: is measured at the same level as the biparietal diameter.

   Femur length: Ultrasound bean should be perpendicular to the bone and measurement is made along the femur diaphysis and should exclude the distal femoral epiphysis.

   Abdominal circumference: should be determined at the level of junction of umbilical vein and portal sinuses. Finally gestational age of foetus is compaired with age of amenorrhoea.

5. **FOETAL ANATOMY**: Systemic examination of fetus is done under following headings:

Skull and spine: Size of skull, presence of vault, size of cerebral ventricles, cavum septum pellucidi, cistern megna protrusion of membrane/brain. The continuity of the vertebral column, any deformity kyphosis/scoliosis, defect in spine or abnormal ossification centre were looked for.

THORAX: Size of thorax, and domes of diaphragm, any abnormal herniation was looked for:

Abdomen: Thickness, continuity of anterior abdominal wall, or any defect in it, ascites, insertion of umbilical cord, stomach bubble for its presence or absence, size and position, kidneys for size status of pelvicalyceal system, presence or absence of any cystic or solid mass, outline of urinary bladder and its distention, any abnormal cystic lesion present in fetal abdomen or fluid in peritoneal cavity was also looked for.

LIMBS: Normal development of limb buds, and movements were looked for.

Ponderal Index of (FL/AC) is ratio of femur length to abdominal circumference, if more than 25%, signifies intrauterine growth retardation.

Fetal weight: It was evaluated by femur length and abdominal

circumference and compared with the standard weight chart.

Congenital anomalies were specifically looked for in every case excluding congenital heart diseases. All observed congenital anomalies were recorded duly in a proforma.

Ultrasound examination was repeated specially in patients who were showing equivocal congenital anomalies at the interval of four to six weeks during third trimester for unequivocal results.

All the included patients were kept as follow up cases till the delivery for the confirmation of presence of congenital anomalies, specially patients who bore the foetus with congenital anomalies during the ultrasound examination.

All the observations were carefully recorded in the proforma and were subjected to appropriate statistical analysis and relevant conclusions were drawn.

OBSERVATIONS

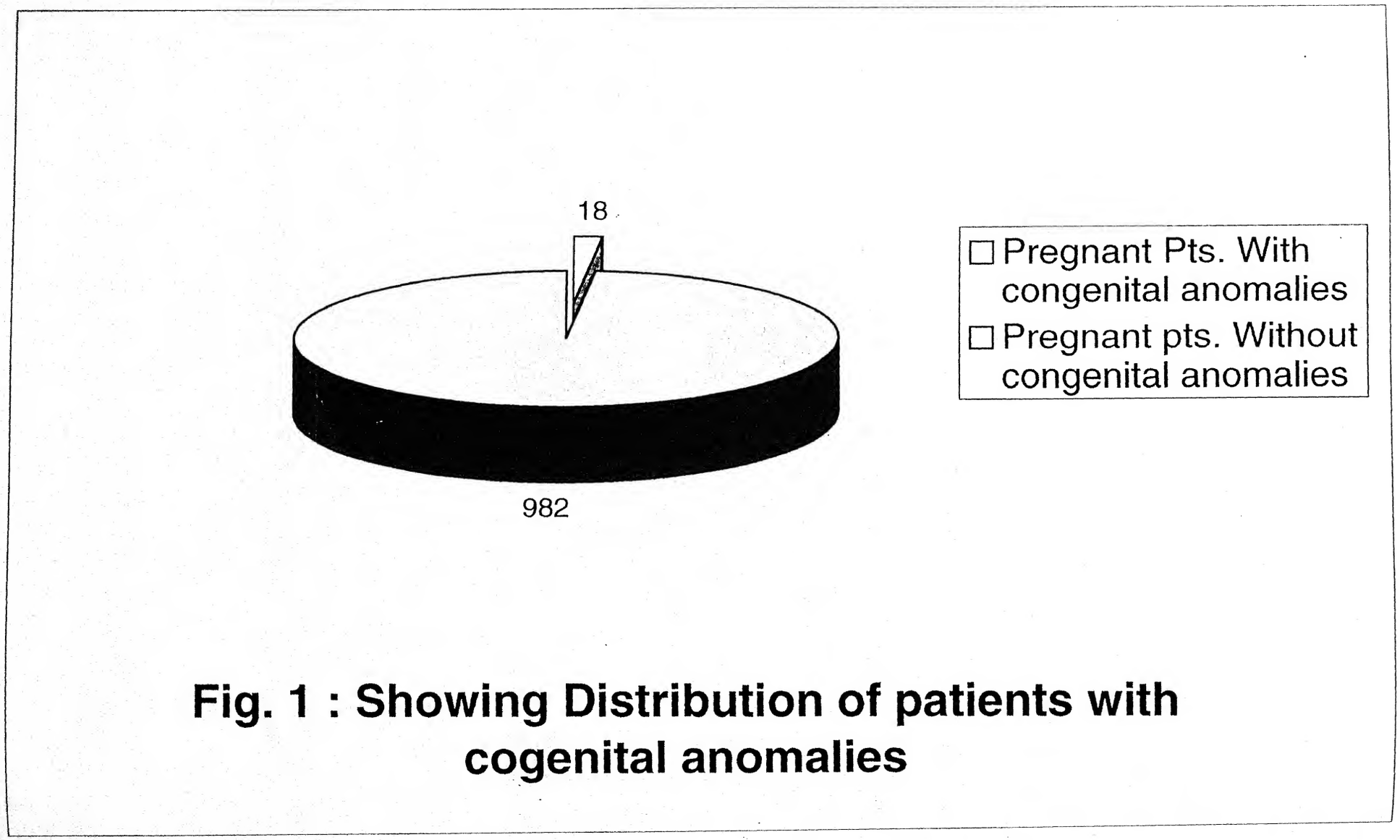


Fig. 1 : Showing Distribution of patients with cogenital anomalies

OBSERVATIONS

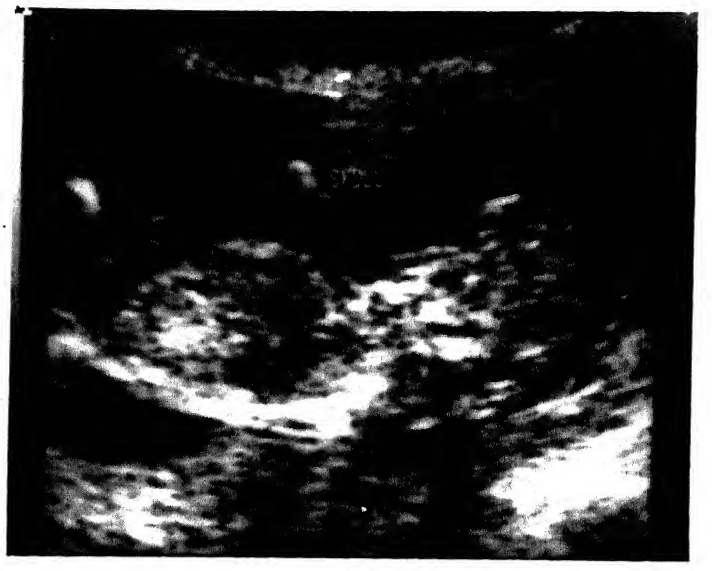
This study was carried out in the Department of Radiodiagnosis with the association of Department of Obstetrics and Gynaecology in M.L.B. Medical College, Jhansi. A total of 1000 patients who attended indoor and outdoor department (O & G) within the period from (Dec. 98 to Dec. 99), were subjected to ultrasound. 18 patients were found to be showing congenital anomaly(es) of foetus. These patients were repeatedly examined and followed upto their delivery.

One thousand pregnant females mean age (25 ± 6.003 yr) were included in the study, out of which 18 patients (Group A) mean age (29.89 ± 7.003 yr) were found to have one or more congenital anomalies (Refer Table 1 and Fig. No. 1).

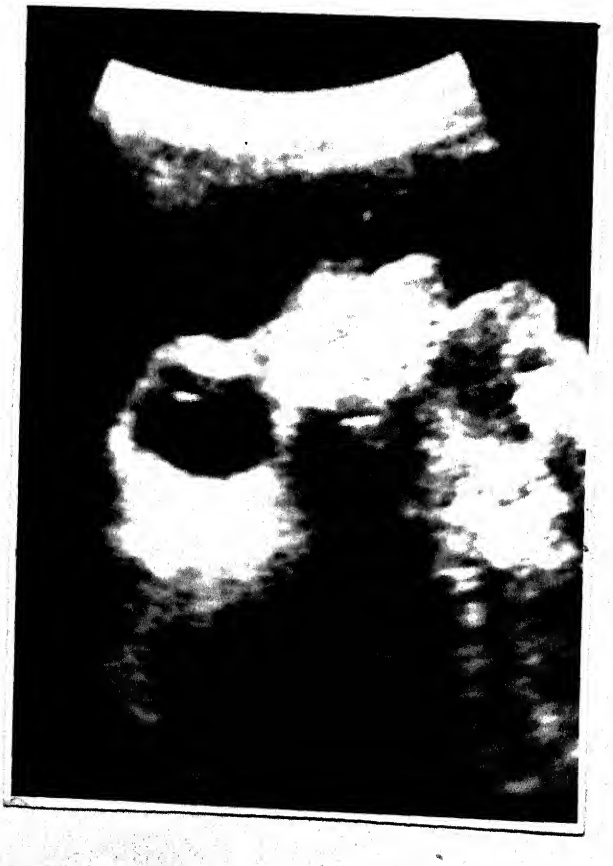
Table 1: Showing Distribution of patients with congenital anomalies.

Group A	Group B	n=total
18	982	1000

Group A – pregnant patients with congenital anomalies in the foetus.



ANENCEPHALY- 18WKS.



ANENCEPHALY-24W

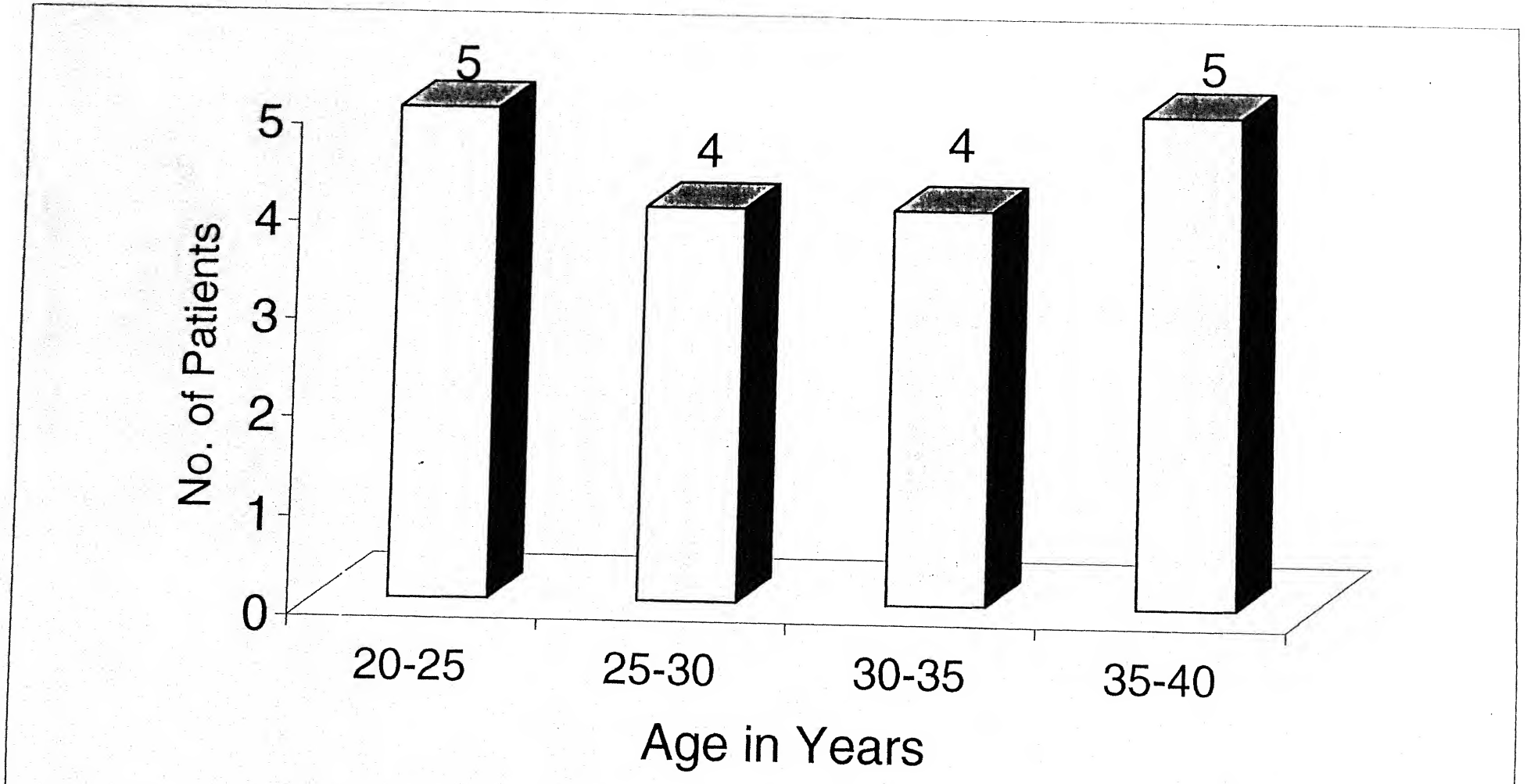


Fig. 2 : Showing Distribution of Age among Group A

Group B – Pregnant patients without congenital anomalies in the foetus.

The number of pregnant patient who showed congenital anomalies during ultrasonographic were grouped as (Group A) as compared to other patients who did not show any congenital (Group B). Group A had a percentage of 1.8% ($p < 0.000$) (highly significant).

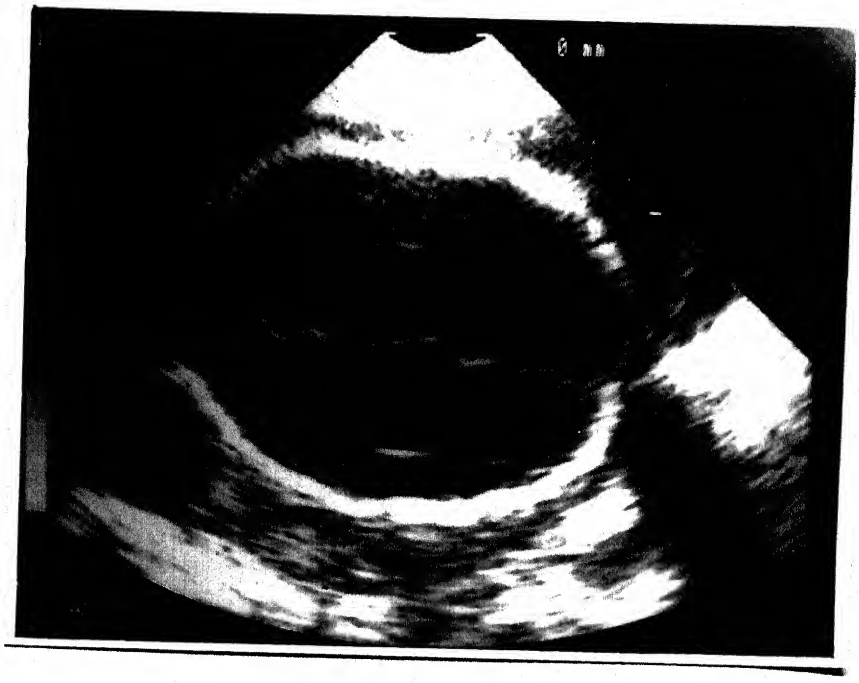
Age Distribution

Mean age among patients of Group A was found to be (29.89 ± 7.003 yr) as compared to Group B i.e. (25±6.003 yr). Age distribution is being shown below (Refer Table No. 2 & Fig. 2).

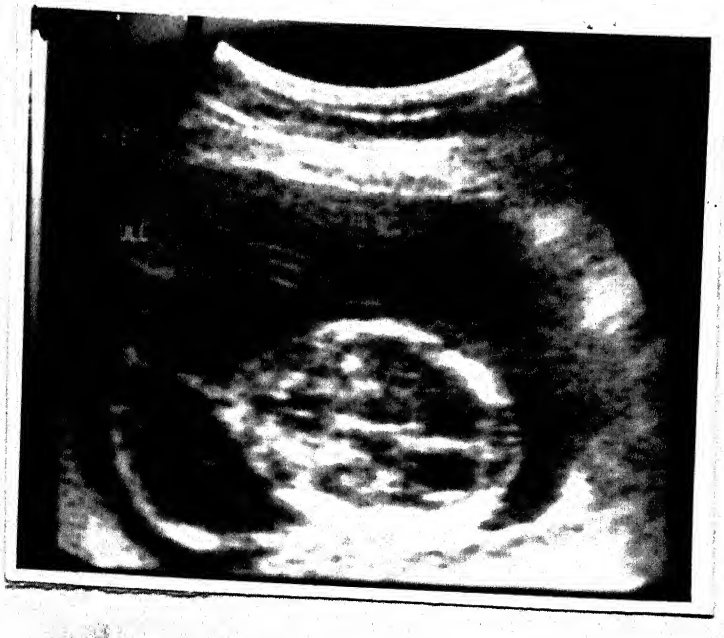
Table 2: Showing Distribution of Age among Group A in number/figure

Age (Yr)	Group A No. of patients	Mean ± SD
20-25	5	
25-30	4	
30-35	4	29.89±7.003
35-40	5	
Total	18	29.89±7.003

As per the table maximum number of patients of group A were found in the age group of 20-25 yrs and 35-40 yrs. There was a



HYDROCEPHALUS



MENINGOCELE

significant difference in the age of Primiparous (mean age 25.17±5.601) yrs as compared to multiparous patients (mean age 32.25 ± 6.58) yrs ($p < 0.0387$).

Distribution of Anaemia:

Anaemia was found to be a very common finding among the patients of both the groups. However, the distribution among patients of group A was found to be among 12 (66.66%) patients with an average hemoglobin of 8.2 gm%.

Distribution of Consanguinity:

Consanguinity among the patients of group A was found to be in 3 patients (16.5%) and only two of them were found to be associated with musculoskeletal and multiple anomalies. However one case showed CNS anomaly.

Distribution of Multiple Pregnancy:

Multiple pregnancy (twin pregnancy) among the patients of group A was found to be in only 3 patients (16.5%) and the rest i.e. 15 (83.5%) had single pregnancy only. In all 3 cases of twin pregnancy one foetus showed congenital anomaly while another foetus was normal.

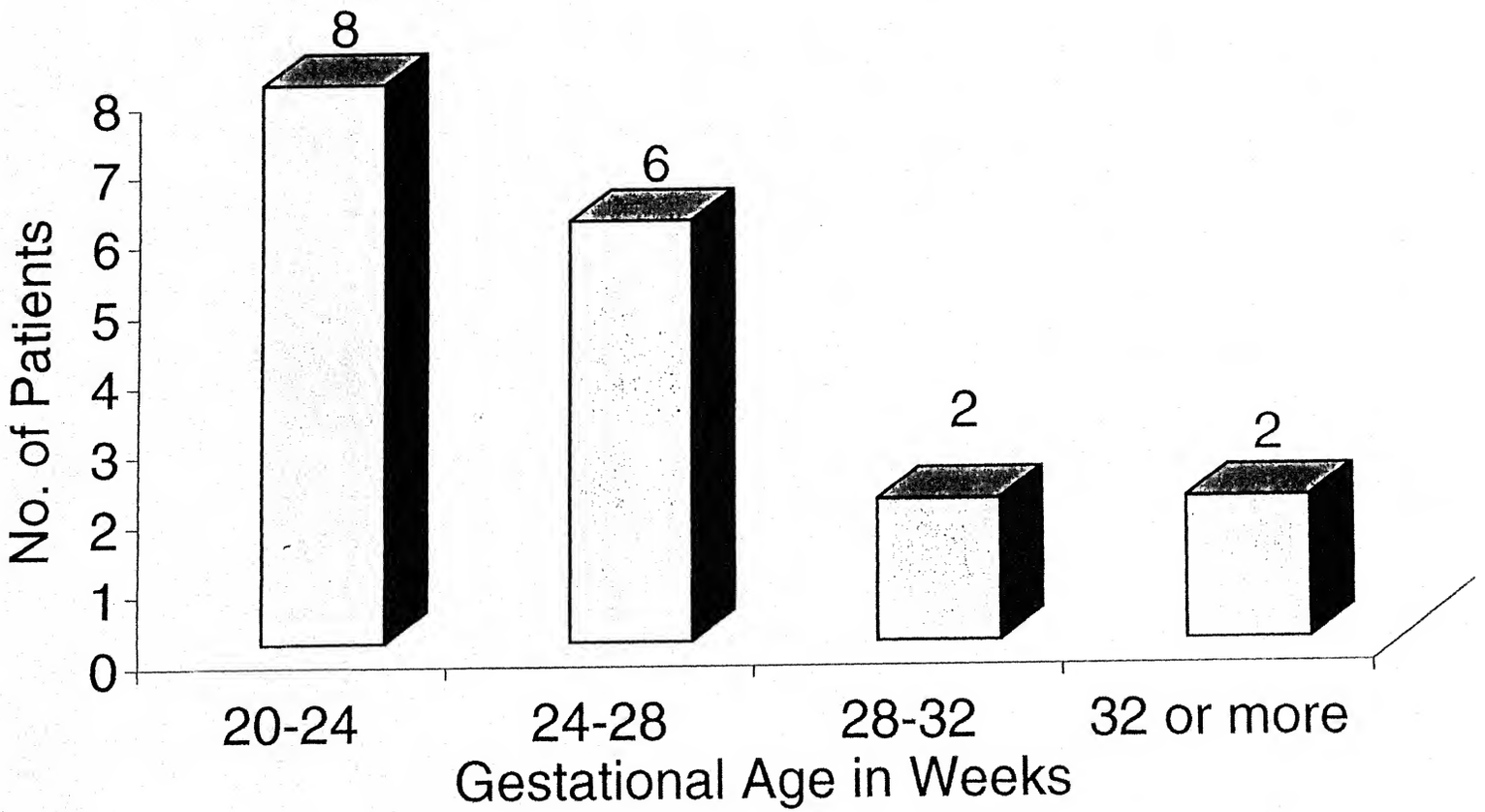


Fig.: 3 Showing Distribution of number of patients according to the Gestational Age among Group A.

Distribution of Maternal Diabetes:

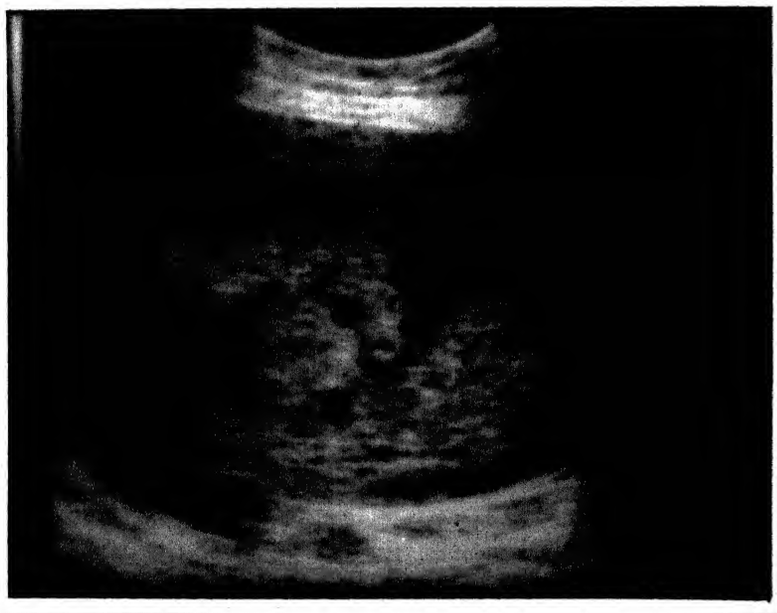
Among group A patients diabetes mellitus was found in 4 (22.4%) patients. However majority (78.4%) of group A patients were non diabetics. The significance for occurrence of congenital anomalies could not be tested due to small number of cases.

Time of Diagnosis of Congenital Anomaly in relation to gestational Age

Mean gestational age among the patients of Group A was found to be (25.53± 4.638 wks) as compared to Group B where it was observed to be (22.40±2.930 wks) however significance could not be tested due to small number of cases. The distribution of number of patients in different gestational groups is being shown (Refer Table No. 3 & Fig. 3).

Table 3: Showing Distribution of number of patients according to the Gestational age among group A

Gestational Age	No. of patients	Total
20 – 24	8	
24 – 28	6	
28 – 32	2	
32- or beyond	2	
Total	18	18



GASTROSCHISIS

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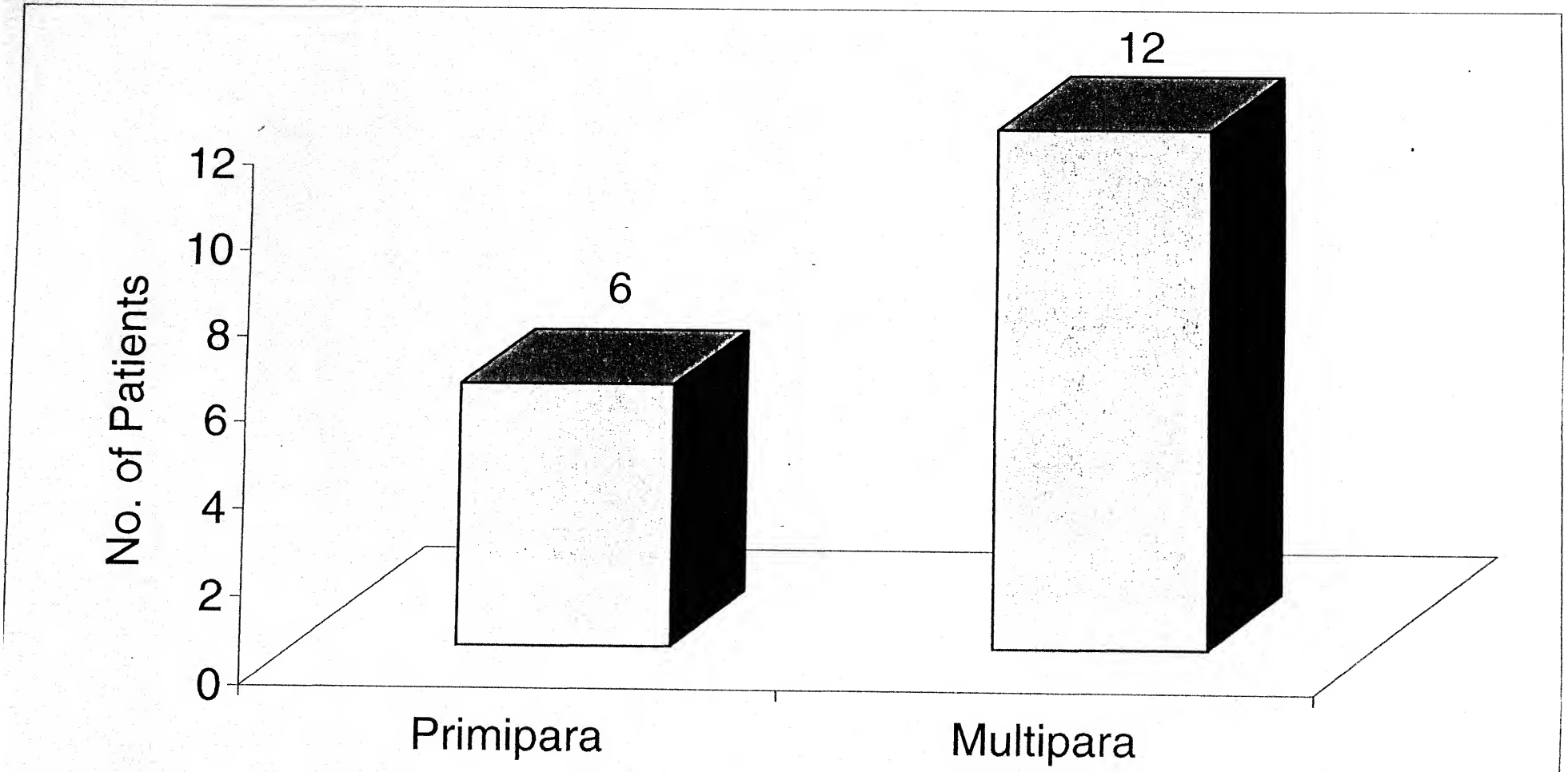


Fig.: 4 Showing Distribution of Parity in Group A

As per above table maximum number of patients showing congenital anomalies were found to be in the gestational age group of 20-24 wks followed by 24-28 wks and gestational age group of 28-36 wks showed relatively lesser number of patients showing congenital anomalies. Earlier diagnosis of congenital anomaly was made in age of 20-24 weeks.

Distribution of Congenital anomaly in relation to parity:

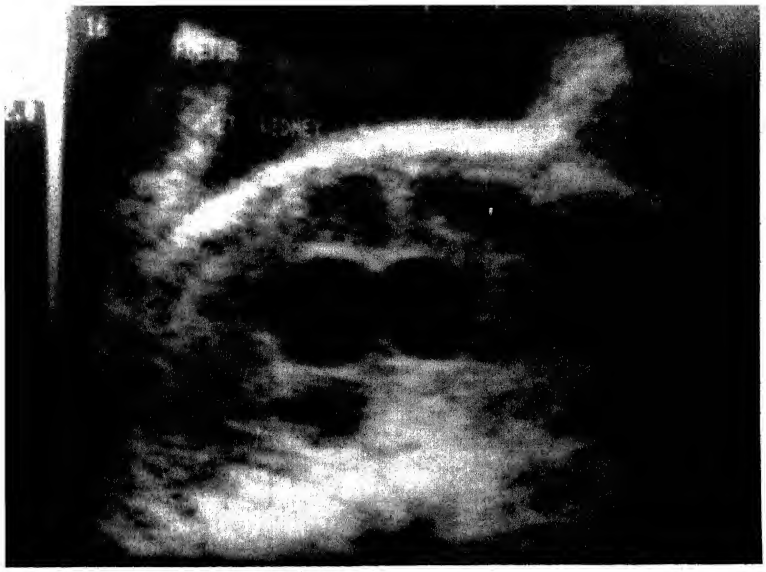
Most of the patients who showed congenital anomalies were found to be multiparus 12 (66.66% and 1.2% of total cases) as compared to primiparus i.e. 6 (33.3%) of 18 patients in group A (Refer to table no. 4 and Fig. no. 4).

Table 4: Showing the distribution of parity in Group A

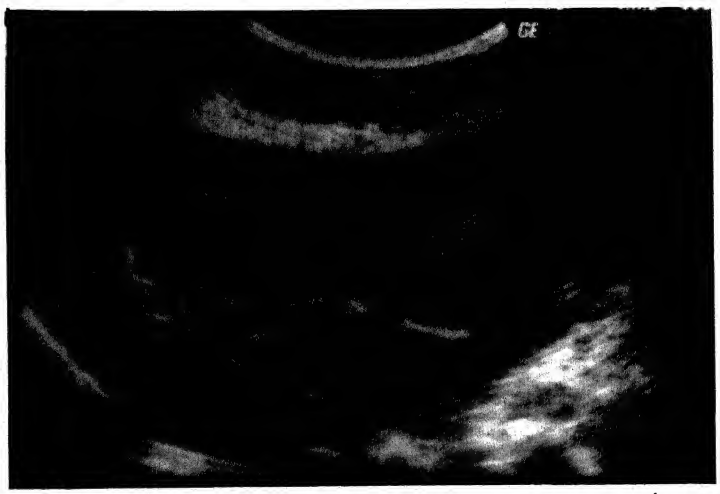
Total No. of cases in group A	No. of Primipara	No.of Multipara
18	6 (33.37%) of group A	12 (66.66%) of group A

Relation of congenital anomaly and amount of liquor

Liquor was found to be oligoamnios in one patient (5.6%) as compared to polyamnios in eight patients (44.8%) of group A



HYDRONEPHROSIS



LIMB-DEFECTS

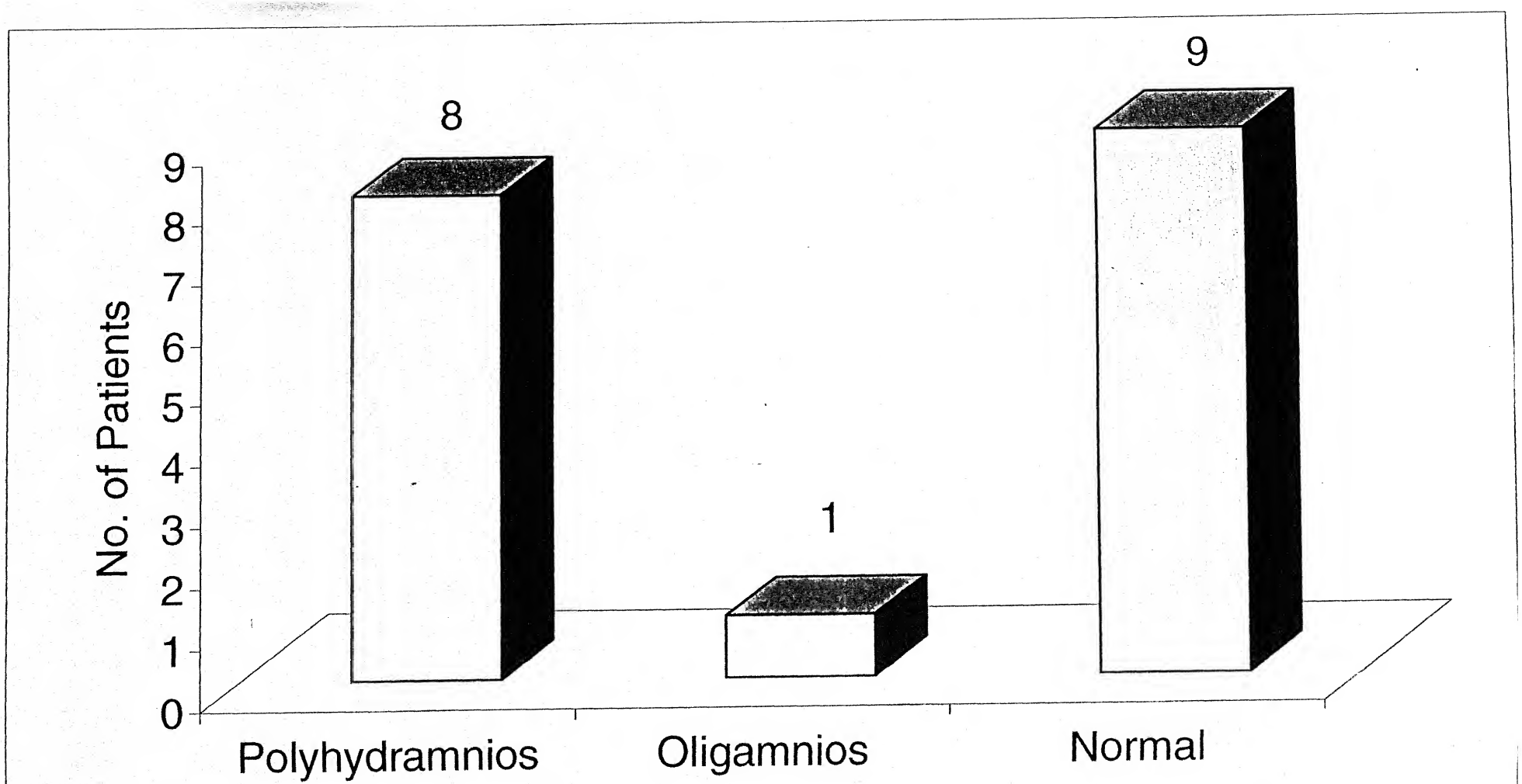


Fig. 5: Showing Distribution of Liquor in Group A

whereas the rest of nine patients (50%) had normal liquor (Ref. to Table no. 5 and Fig No. 5).

Table No. 5: Showing distribution of amount of liquor in Group A patients.

Liquor	No. of patients	Percentage
Polyhydramnios	8	44.8
Oligoamnios	1	5.6
Normal	9	50
Total	18	100

All cases of Anencephaly, Meningoencephalocele, Meningocele, gastroschisis and omphalocele were associated with polyhydramnios.

Oligoamnios was found to be associated with one twin pregnancy and of them one foetus had hydronephrosis.

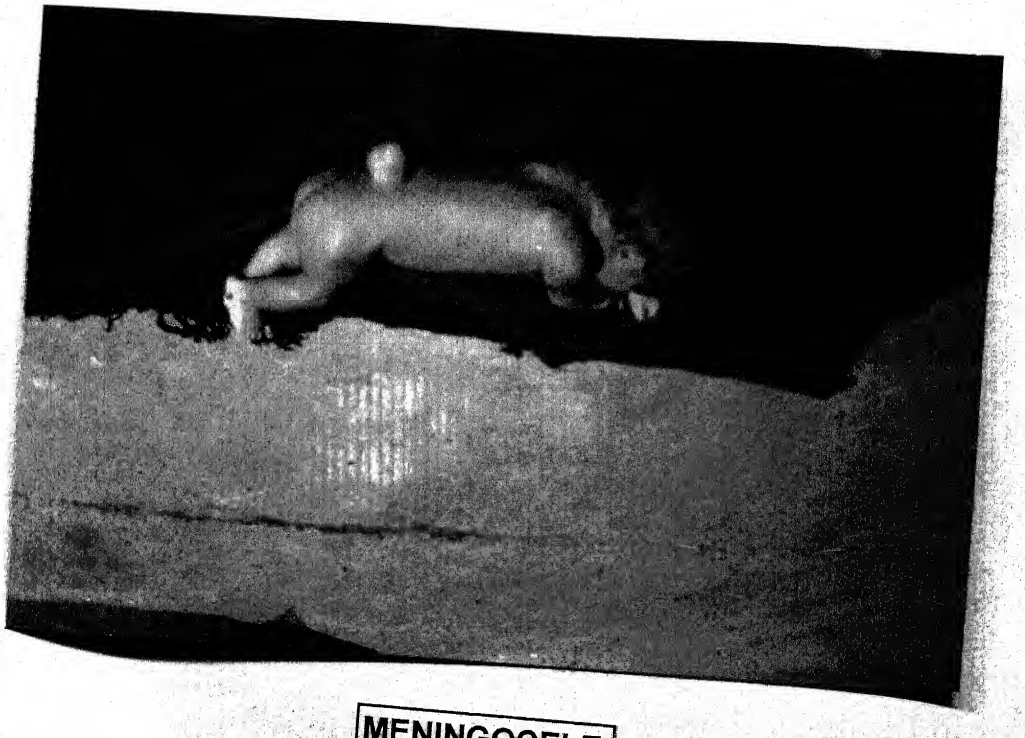
Distribution of various Congenital Anomalies:

Out of 18 patients of group A, 9 cases showed one or more Central Nervous System anomalies with a distribution of:

Anencephaly .6% of total and 33.3% of group A

Hydrocephalus .3% of total and 16.7% of group A

HYDRANENCEPHALY



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Meningoencephalocele .1% of total and 5.6% of group A

Meningocele .1% of total and 5.6% of group A

Gastrointestinal anomalies included diaphragmatic hernia and enteric cyst with .1% incidence of each.

Aneterior abdominal wall defects included gastroschisis and omphalocele and were found to be two cases of each i.e. .2% incidence of each.

Hydronephrosis was found in one case (.1% incidence) and associated with oligohydroamnios. However no other renal anomaly was detected in the present study.

Among musculoskeletal anomalies, limb defects were observed in 2 cases i.e. .2% of total (Ref. To Table No.6 and Fig. No.6).

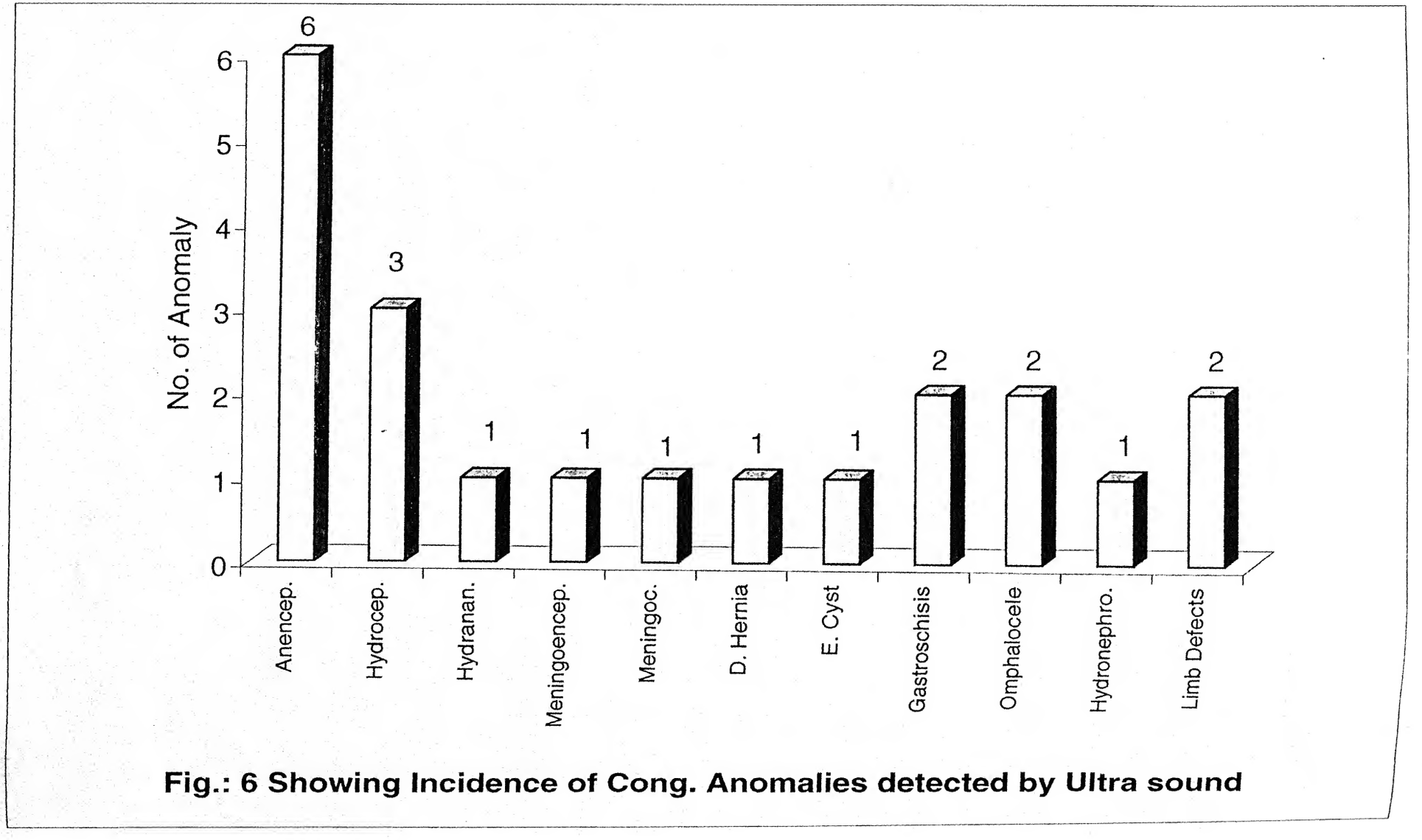


Fig.: 6 Showing Incidence of Cong. Anomalies detected by Ultra sound

Table 6: Showing incidence of congenital anomalies detected by Ultrasound

Types of major anomaly	No. of different Anomaly	Percentage
A. CENTRAL NERVOUS SYSTEM		
Anencephaly	6 (Six)	.6%
Hydrocephaly	3 (Three)	.3%
Hydranancephaly	1 (One)	.1%
Meningoencephalocele	1 (One)	.1%
Meningocele	1 (One)	.1%
B. GASTROINTESTINAL SYSTEM		
Diaphragmatic hernia	1 (One)	.1%
Enteric cyst	1 (One)	.1%
C. ABDOMINAL WALL DEFECTS		
Gastroschisis	2 (Two)	.2%
Omphalocele	2 (Two)	.2%
D. URINARY SYSTEM		
Hydronephrosis	1 (One)	.1%
E. MUSCULOSKELETAL SYSTEM		
Limb Defects	2 (Two)	.2%

GASTROSCHISIS

HYDROCEPHALUS

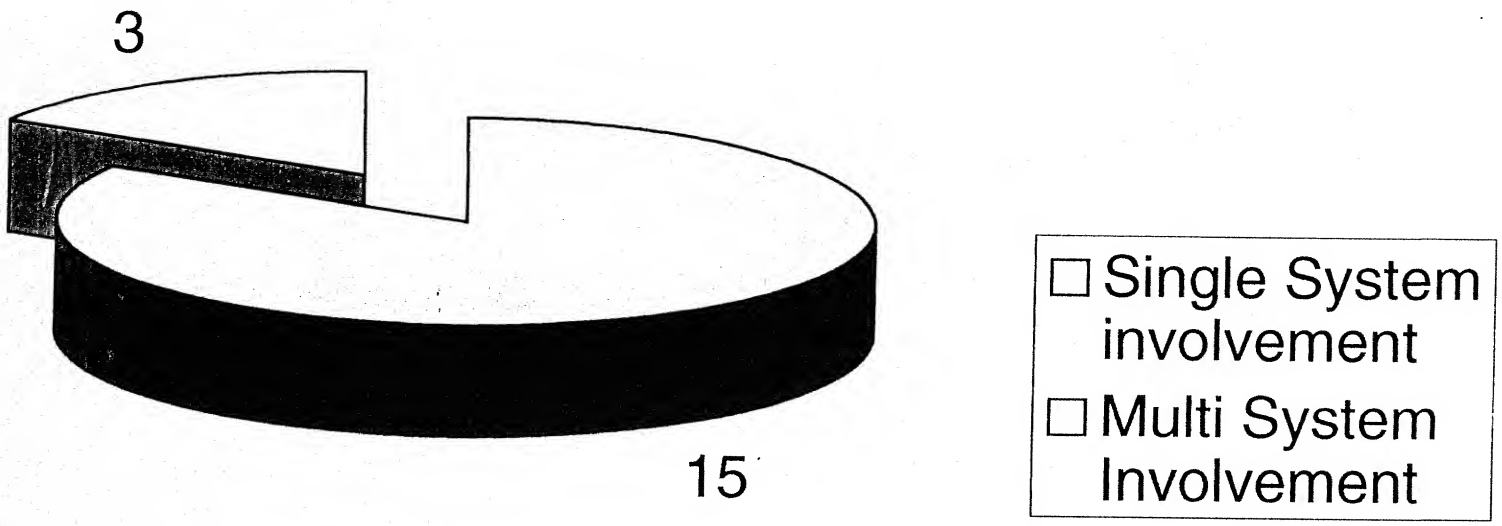


Fig. : 7 Showing Distribution of Single or Multi System Involvement in Group A

Multisystem Anomalies in Foetus:

Among all the 18 foetus of group A, three patients i.e. 16.8% had multisystem anomalies named (a) abdominal wall defects and musculoskeletal defects (b) Anencephaly and omphalocele (c) hydrocephalus and meningoencephalocele (Ref. To Table No. 7 and Fig. No.7).

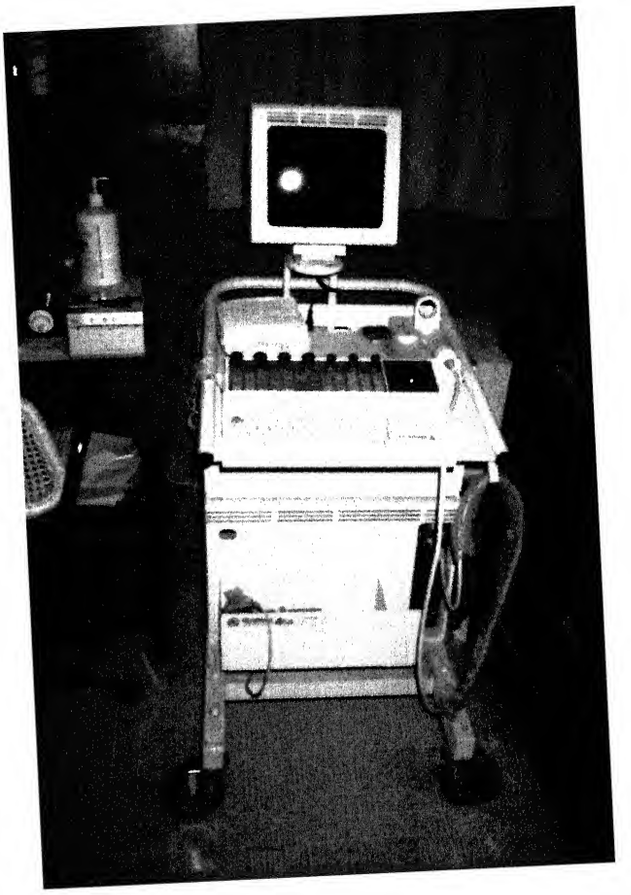
Table No.7: Single or multisystem involvement in congenital Anomaly.

Total No. of cases	Single system involvement	Multisystem involvement
18	15 (83.2%)	3 (16.8%)

Correlation of various variables of the study:

In the present study multiparity was found to be present more commonly with CNS anomalies as compared to primiparous but significance could not be tested due to small number of cases in Group A.

In relation to musculoskeletal anomalies, the aforementioned relation was observed with primiparous but a variable relation with GIT and renal anomalies.



ULTRAMARK IV PLUS ULTRASOUND MACHINE

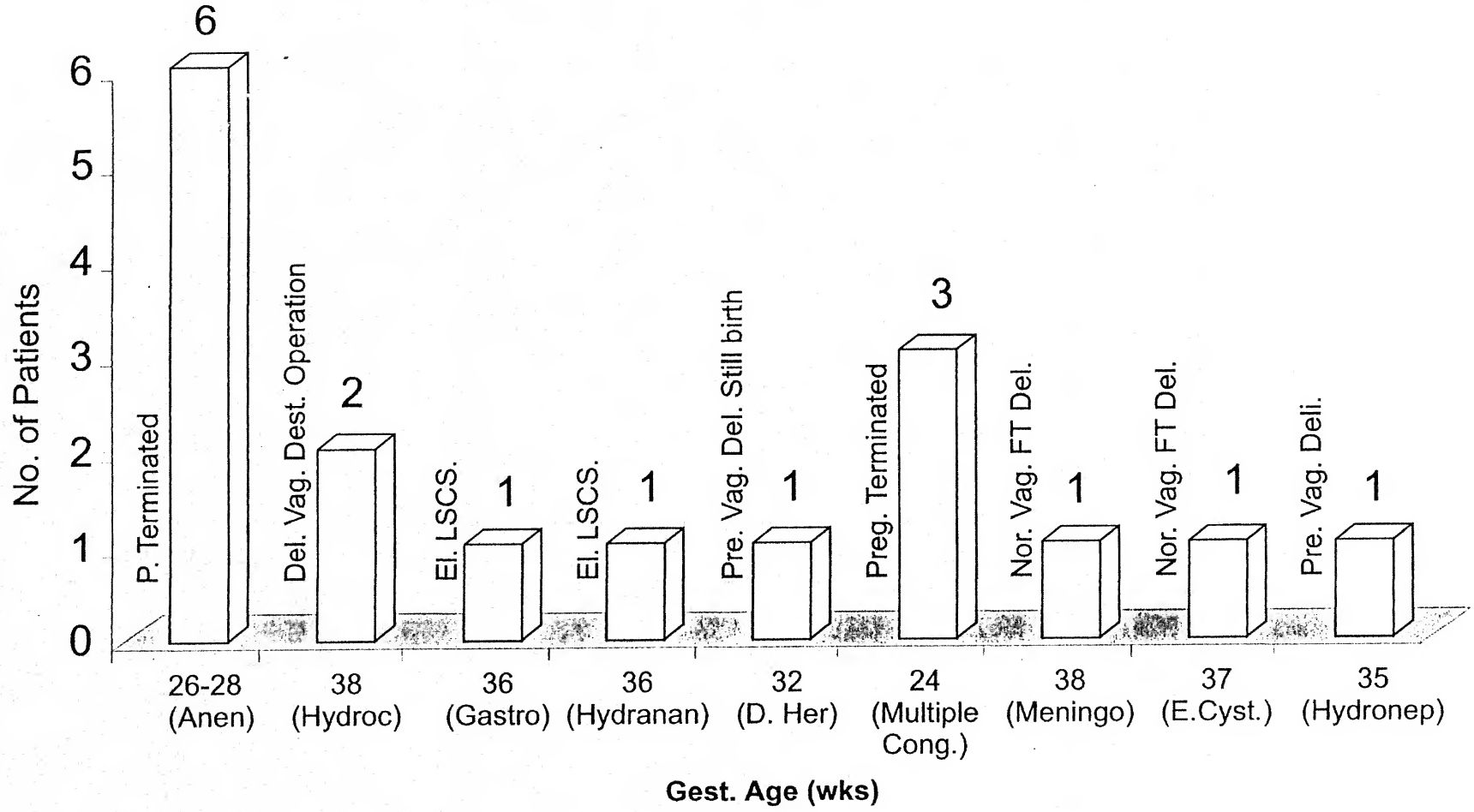


Fig. 8 : Showing Fate of various Congenital Anomalies in Group A

Follow up of all the patients of group A

All 18 patients among Group A were followed till delivery results were (Refer Table no.8 & Fig. no. 8).

Table 8: Showing fate of various congenital anomalies

	Event	Anomaly	No. of Cases	Gestational age (wks)
1	Pregnancy terminated	Anencephaly	6	26-28
2	Delivered vaginally by destructive operation	Hydrocephalus	2	38
3	Elective LSCS	Gastroschis & hydranancephaly	One eac	
4	Premature vaginal delivery stillbirth	Diaphragmatic hernia	1	32
5	Pregnancy terminated	Multiple congenital anomalies	3	24
6	Normal full term vaginal delivery	Meningocele enteric cyst	1 1	38 37
7	Premature vaginal delivery	Hydronephrosis omphalocele	1	35

As shown in Table 8 various future events were carried out as mentioned and termination of pregnancy was found to be the most common outcome followed by elective LSCS and destructive operation and vaginal delivery.

DISCUSSION

DISCUSSION

Ultrasonography represents the most significant advance in obstetrics diagnosis and clinical management in the past 30 yr. No deleterious effects of ultrasound (in the frequencies commonly used in clinical practice) have been documented in either the mother or fetus (American Inst. Of USG in Medicine, 1988). The largest risk of antenatal sonography is probably misdiagnosis. Although false diagnosis (false positive findings) may lead to parental anxiety, these errors can be corrected by a second, usually more detailed, ultrasound study performed in a tertiary referral center. A missed diagnosis (a false negative finding) remains undetected unless the patient undergoes a second sonographic study for another indication. Technology has limitations and those of obstetric sonography should be discussed with the patient before any study is performed. These limitations are often gestational age – dependent. Thus, obstetric sonography should be performed at an appropriate gestational age by an experienced practitioner.

Antenatal ultrasonography is readily accepted by patients and their families. Patient derive reassurance from the image of a fetus

moving about in utero. Ultrasound studies are commonly requested by the patient during antenatal care, and is often attended by patients immediate family. Sonography provides a simple, non-invasive and reliable means for prenatal detection of congenital anomalies Screening of every obstetric case should be done after 14 wk because prior to this period, anatomical structures of foetus are too small for systemic evaluation by ultrasound. Major organogenesis is complete after 14 wks (Barkin et al. 1987, Campell & Pears, 1983).

The present study overwhelmingly proves that almost all forms of major congenital malformations (Cardiac anomalies being excluded in the present study) should be diagnosed at an earlier period of gestation, certainly between 21-28 wks. All the anomalies which are detected late in second trimester and some in the third trimester are amenable for an early detection around 14-18 wk. Late detection in the present study was due to late seeking of medical advice by patients.

In the present study, 18 patients (1.8%) of major congenital anomalies were detected, which is comparable to the previous Indian studies with similar exclusion criteria (K. Saxena, S. Hakim et al 1997). Western studies show major birth defects varying from 2-8%

(Etan Z. Zimmer, Z. Avrahaan et al 1977; Annette Q, Herwig S et al 1998).

This difference in the percentage of major malformations could be due to our exclusion criteria for cardiac malformations which account for a substantial percentage of anomalies and the prevalence of anomalies as well.

Major congenital anomalies were found to be in the age group of 20-25 yr (28%) and 35-40 yr (28%). This may not be indicating any significant figure relating to congenital anomalies and further studies are required to support or refute the same.

In the present study majority of the major congenital anomalies were found to be between the gestation age of 20-32 wk i.e. (1.6%) patients and this is in accordance with the previous studies (Annette Q, Herwig S et al 1998).

In the present study, occurrence of maternal Anaemia, Parity, Diabetes mellitus, consanguinity were noted and following findings were found -

- Most of the patient (66.6%) with congenital malformation were found to be anaemic (Mean Hb 8.2 gm%).

- (66.6%) of the patients with congenital malformations were found to be multiparous.
- Consanguinity was present in (16.5%) of the patients with congenital anomalies.
- (16.5%) patients, who showed congenital anomalies were having multiple pregnancy (twin pregnancy).
- Out of patients showing congenital malformations (22.4%) were diabetics.

As for statistical significant correlation was concerned, our study could not yield enough information and further longer period studies are required to support or refute the aforementioned findings.

Most of the congenital anomalies belonged to the **Central Nervous System** with the break up distribution of Anencephaly (33.3%), Hydrocephalus (16.7%), Hydranencephaly (5.6%) and Meningoencephalocele (5.6%) and Meningocele (5.6%). These findings are in accordance with the previous studies (Amette Q, Herwig S. et al 1998, K. Saxena, S. Hakim. et al 1997). Maximum number of congenital anomalies were being observed in central nervous system, however the breakup distribution was variable and the possible reason of this variation could be the difference in the

prevalence of congenital anomalies and difference in the individual detection due to various causes, which has a bearing on the detection of various anomalies.

Gastrointestinal anomalies in our study were found to be diaphragmatic hernia (5.6%) and enteric cyst (5.6%) among the observed congenital anomalies and were found to be more common as compared to previous national study (K.Saxena, S. Hakim. et al 1997) and the possible reason could be geographic variation or observer differences but further studies are required to vindicate or refute the present findings.

Percentages of various **renal, musculoskeletal and multisystem anomalies** vary in our and the previous national and international studies (Etan Z, Z Avraharan et al 1997) and possible reason could be either difference in the prevalence, observer variation and perhaps some other factor that is yet to be worked out and is hoped to be taken up by future works in the same field.

As in the previous studies (K. Saxena, S. Hakim et al 1997, Etan Z, Z Avraharan et al 1997) detection of the congenital anomalies does help in planning for the future outcome of pregnancy in appropriate ways thus, reducing the number of anomalies at birth and

the various methods of planning could be either termination of pregnancy, vaginal delivery by destruction or other means e.g LSCS therefore the load of congenital anomalies at birth could be reduced and simultaneously the emotional stress of the parents and society could be taken care of accordingly.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

1. Major congenital anomalies were present in (1.8%) of patients during routine ultrasonographic examination.
2. **Central nervous system anomalies** were found to be the commonest congenital anomalies (50%).
3. Among Central nervous system anomalies **Anencephaly** (6/1000 incidence), **Hydrocephaly** (3/1000 incidence), **Hydranencephaly** (1/1000 incidence) and **Meningoencephalocele** and **Meningocele** (1/1000 incidence of each) were the anomalies with appropriate number along with.
4. Among gastrointestinal and anterior abdominal wall anomalies were **diaphragmatic hernia** (1/1000), **Enteric cyst** (1/1000 incidence), **Gastroschisis** (2/1000 incidence) and **Omphalocele** (2/1000 incidence).
5. Among Renal anomalies and fetal ascites – None had **renal agenesis** and **extrophy of bladder**, **Hydronephrosis** (1/1000 incidence) and **Fetal Ascites** (3/1000 incidence).
6. **Musculoskeletal anomalies** (shortening of limbs) were found in (2/1000 incidence).

7. **Multisystem congenital anomalies** were observed in (3 foetuses) out of 18.
8. Percentages of congenital anomalies could be reduced at birth as appropriate obstetric management was carried out e.g. **pregnancy termination** (6 patients – 26-28 wk), **vaginal delivery** by **destructive procedures** (2 patients – 38 wk), **elective LSCS** (2 patients – 37-38 wk), **premature vaginal delivery** at 32 wk (1 patients), **pregnancy terminated** (1 patient – 24 wk).

Conclusion

Detection of major congenital anomalies by routine **ultrasonographic** screening after **12 wks** of gestation could be emphasized by the present study and possible benefits could be extended to not only the mother but even the relatives and society by reducing the load of congenital anomalies through appropriate planning thus significantly reducing the birth of physically and mentally handicapped children who could have become nothing but liabilities of the concerned families, society and the nation and above all the emotional trauma of the mother and family could well be minimized thus adding a bit whatsoever to the quality of their lives.

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BIBLIOGRAPHY

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